

Final Report

**IMPROVING QUALITY MANAGEMENT SYSTEMS (QMS) FOR
PIPELINE CONSTRUCTION ACTIVITIES**

Improving Quality Management Systems (QMS) for Pipeline Construction Activities

**Prepared for
Department of Transportation (DOT), Pipeline
Hazardous Materials Safety Administration (PHMSA)**

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Det Norske Veritas (U.S.A.), Inc. (DNV GL) and the Pipeline and Hazardous Materials Safety Administration (PHMSA) co-funded the project titled, "Improving Quality Management Systems (QMS) for Pipeline Construction Activities". The main objectives of this project were to develop guidance pertaining to issues related to construction quality of a new pipeline and how these issues could be addressed through standards, specifications, and in the field; to develop general guidelines for a QMS for pipeline projects to provide greater assurance of consistent and acceptable quality; and to suggest enhancements to regulations and standards to improve the overall quality of new pipelines through application of a QMS.

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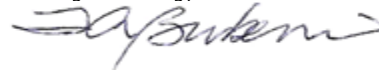


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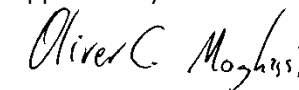


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This report presents findings and conclusions based on technical services performed by Det Norske Veritas (U.S.A.), Inc. ("DNV GL"). The work addressed herein has been performed according to the authors' knowledge, information and belief based on information provided to DNV GL, in accordance with commonly accepted procedures consistent with applicable standards of practice. The report and the work addressed herein is not, nor does it constitute, a guaranty or warranty, either express or implied. DNV GL expressly disclaims any warranty or guaranty, either express or implied, including without limitation any warranty of fitness for a particular purpose. The analysis and conclusions provided in this report are for the sole use and benefit of the party contracting with DNV GL to produce this report (the "Client"). No information or representations contained herein are for the use or benefit of any party, person, or entity, other than the Client. The scope of use of the information presented herein is limited to the facts as presented and examined, as outlined in this document. No additional representations are made as to matters not specifically addressed within this report. Any additional facts or circumstances in existence but not described or considered within this report may change the analysis, outcomes and representations made in this report. Any use of or reliance on this document by any party other than the Client shall be at the sole risk of such party. In no event will DNV GL or any of its parent or affiliate companies, or any of its or their respective directors, officers, shareholders, and/or employees be liable to any other party regarding any of the findings and recommendations in this report, or for any use of, reliance on, accuracy, or adequacy of this report.



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1 EXECUTIVE SUMMARY

This research study was funded by the Department of Transportation (DOT), Pipeline Hazardous Materials Safety Administration (PHMSA) as part of a larger set of efforts to improve construction quality with the pipeline infrastructure in the United States. The pipeline construction quality management system (QMS) framework developed as part of this effort directly ties back to deficiencies found via PHMSA inspections of construction activities and those as noted by a series of public events sponsored by PHMSA and others. The pipeline construction industry has experienced unparalleled growth since 2007, resulting in increased construction inspections by PHMSA. Inspection findings, in conjunction with pressure test failures and failures in the first year of operations, have identified pipeline construction quality as a source of concern.


A proven method for improving quality in other industries is through the implementation of a quality management system (QMS). One widely accepted QMS used across industries is ISO 9001; additionally, several QMS standards specific to the oil and gas industry have been developed. In 2012, the INGAA Foundation (INGAA) published a white paper that explored the benefits of applying QMS principles to the field implementation phase of pipeline construction projects. Identified benefits also included regulatory compliance and unnecessary cost avoidance (or cost optimization).

In 2013, PHMSA solicited proposals for a research and development project titled, "Improving Quality Management Systems (QMS) for Pipeline Construction Activities" (DTPH56-13-RA-000002). Det Norske Veritas (U.S.A.), Inc. (DNV GL) was awarded this contract and co-funded the 16-month research and development effort.

DNV GL developed a QMS framework for pipeline construction activities and an accompanying guidance document. The framework and guidance document are intended to assist pipeline operating companies and contractors in the development and implementation of a company-specific QMS for pipeline construction. The framework adopts a risk-based, process approach, as defined in other QMS and management system documents, and is designed to be scalable for a wide range of pipeline construction projects, including liquid and gas transmission pipelines and gas distribution lines. It should be noted that while gathering lines were considered outside of the scope of this document, the principles herein could be applied to develop a QMS for gathering lines.

The QMS framework (Appendix A) and guidance document (Appendix B) are intended to be used either as a stand-alone management system or as the quality component in a company's corporate management system. The framework includes the general management system components, as well as specific sections on implementation of a QMS for a pipeline construction project, from materials procurement and inspection through pre-commissioning. The framework addresses the following:

- Responsibilities of the pipeline owner/operator, construction contractor(s), and supplier(s);
- Management commitment;
- Communications, documentation, and management of change of the QMS;
- Resource management and training;
- Project implementation of the QMS, including:
 - Identification of task-specific or process-specific quality concerns;
 - Identification, development, and application of quality control/ quality assurance options to address each concern in order to prevent, detect, mitigate, and eliminate near-misses and non-conformances;
 - Training and competency of personnel performing the tasks as well as personnel inspecting and monitoring the tasks and deliverables;
 - Identification and description(s) of applicable inspection requirements; and
 - Construction project documentation requirements; and

- 
- Continuous improvement via assessment of the achievement of quality objectives throughout the implementation of the QMS and construction project(s).

Additionally, it should be noted that the guidance document is a set of recommendations, suggestions, and examples that may be considered when developing the details of how to meet the requirements of the framework.

It should be noted that PHMSA requested that DNV GL survey and interview representatives from industry organizations in support of information gathering and coordination of this project. In addition to the PHMSA Construction Team, the industry organizations contacted¹ included: American Gas Association (AGA), Association of Oil Pipe Lines (AOPL), American Petroleum Institute (API), Canadian Energy Pipeline Association (CEPA), Interstate Natural Gas Association of America (INGAA), National Association of Pipeline Safety Representatives (NAPSR), National Energy Board (NEB) Canada, Pipe Line Contractors Association (PLCA), Pipeline Research Council International (PRCI), and Pipeline Safety Trust (PSTrust).

During the course of this project, additional industry work has been undertaken to develop pipeline construction specific QMS, including a 2014 report published by INGAA on the guidelines for practical implementation of a construction QMS and the formation of an American Petroleum Institute (API) task group in 2015 to develop a recommended practice for pipeline construction QMS.

¹ Please note that not all of the industry organizations contacted chose to participate in the project.

2 INTRODUCTION

Since 2007, the pipeline industry has experienced a large increase in pipeline construction, and numerous quality issues have been identified during construction inspections performed by the Department of Transportation (DOT) Pipeline Hazardous Materials Safety Administration (PHMSA). These inspections, coupled with several pre-commissioning pressure test failures, first year in-service failures, and other material and construction problems identified during construction or pre-commissioning inspection and surveying, brought construction quality to the attention of the oil and gas pipeline industry.

The industry's initial strategy was to discuss the issues via workshops, some of which included:

- "Building Better Natural Gas Pipelines - Continuous Improvement Workshop" hosted by The INGAA Foundation (INGAA) in Houston, Texas on March 25 and 26, 2009;
- "Pipeline Safety - New Pipeline Construction Workshop" hosted by PHMSA and co-sponsored by the Federal Energy Regulatory Commission (FERC), Canadian National Energy Board (NEB), and National Association of Pipeline Safety Representatives (NAPSR) in Fort Worth, Texas on April 23, 2009; and
- "Distribution Construction Workshop" hosted by PHMSA in St. Louis, Missouri on April 20, 2010.

In addition to workshops, PHMSA issued two advisory bulletins directly related to quality issues identified on new pipeline construction:

- ADB-09-01, "Pipeline Safety: Potential Low and Variable Yield and Tensile Strength and Chemical Composition Properties in High Strength Line Pipe" on May 21, 2009; and
- ADB-10-03, "Pipeline Safety: Girth Weld Quality Issues Due to Improper Transitioning, Misalignment, and Welding Practices of Large Diameter Line Pipe" on March 24, 2010.

In 2009, PHMSA sent letters to executives at several industry groups to reinforce the importance of the problems discussed in the PHMSA and industry workshops, and to solicit continuing action from the industry to address them. The letters were set to the American Gas Association (AGA), American Petroleum Institute (API), Association of Oil Pipe Lines (AOPL), INGAA, and INGAA Foundation. The following challenges were highlighted in the letters:

- The ability to credibly define the precise nature and extent of problems identified during new pipeline construction projects;
- Identification of current underlying standards or regulations to be re-examined or changed to help improve pipeline fabrication and construction quality control; and
- Identification of other ideas to improve overall fabrication and construction quality control.

Additionally, the letters from PHMSA included the following questions for the industry groups:

- What is the value of developing a more comprehensive quality management system standard to make these improvements and what system elements are recommended;
- Which testing and quality control requirements should be incorporated into all new pipeline construction projects prior to commissioning; and
- How can we ensure that workers employed in these fast-paced and challenging construction projects are fully trained and qualified to carry out their duties competently?

To assess the magnitude of the construction quality issues, a review of pipeline incident data since 2010 on PHMSA-regulated pipelines was conducted, including hazardous liquid, gas transmission, and gas distribution pipelines [1]. To separate incidents that were likely caused by material or construction issues, only incidents with a listed cause of "material failure of pipe or weld" were included. Additionally, for hazardous

liquid and gas transmission incidents, only cause details of “original manufacturing related (not girth weld or other welds formed in the field)” or “construction-, installation-, or fabrication-related” were included²; this eliminated environmental cracking incidents from consideration. The data analysis revealed that 206 incidents were reported since 2010 that were caused by materials or construction issues. For pipelines installed in the past 20 years, well within their intended design life, a total of 21 material or construction failure incidents were reported: 11 on hazardous liquid pipelines, four on gas transmission pipelines, and six on gas distribution lines.

3 IMPROVING PIPELINE CONSTRUCTION QUALITY

3.1 MANAGEMENT SYSTEMS

A management system is a systematic framework for managing and continually improving an organization’s policies, processes, and procedures. Simply put, a management system is how an organization ensures things are done properly. All formal and informal processes that enable an organization to deliver its products or services make up the company’s management system. The best management systems help a business work with a shared vision through communications, benchmarking, team work, and working to the highest quality, safety, and environmental principles.

A formal management system is a documented set of interrelated and interdependent processes with a clearly defined scope. A formal management system is more than a set of documents: it is a documented system of working that follows the Plan-Do-Check-Act methodology, shown in Figure 1, below. Effective management systems include documented processes, clear responsibilities, ongoing training, communication requirements, compliance checks, processes to correct non-compliances, management reviews, and continual improvement.

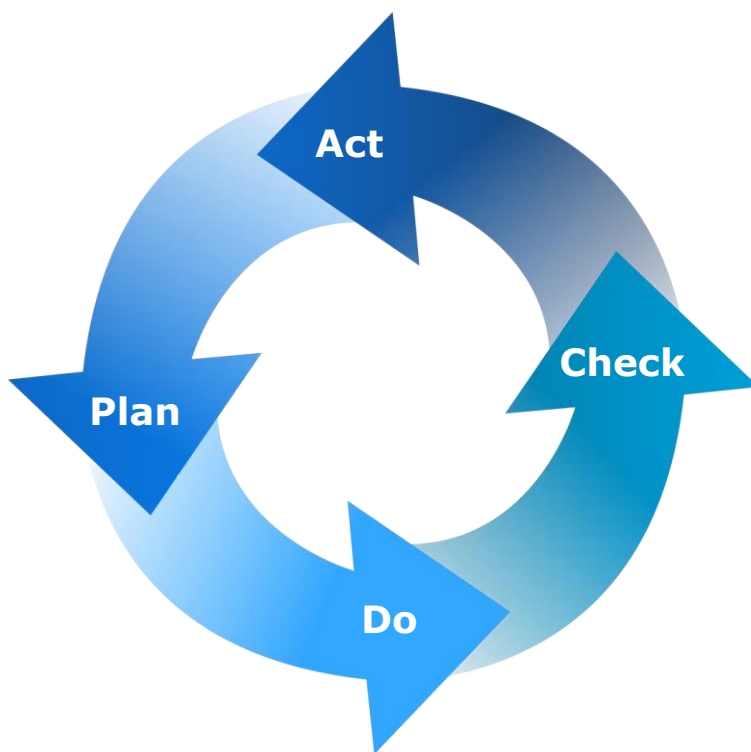


Figure 1. PDCA Methodology

² The gas distribution incident data did not contain “cause details.” Therefore, all incidents caused by “material failure of pipe or weld” were included.

3.2 QUALITY MANAGEMENT SYSTEMS

A Quality Management System (QMS) is the documented set of processes and procedures required for planning, executing, and continually improving the ability of a process, activity, or product to meet defined requirements. A QMS should follow the Plan-Do-Check-Act methodology to achieve high quality and continuous improvement. It should:

- Document all requirements in appropriate locations;
- Confirm employees and contractors receive applicable training;
- Define processes, procedures, and activities needed to meet quality requirements;
- Require proper and timely communication between interrelated processes, procedures, and activities;
- Produce evidence the quality requirements are met;
- Measure, monitor, and analyze changes to the requirements;
- Audit and analyze system processes and outcomes; and
- Improve quality.

One widely accepted QMS is ISO 9001 [2], which explains,

"A quality management system can provide the framework for continual improvement to increase the probability of achieving customer satisfaction and the satisfaction of other interested parties. It provides confidence to the organization and its customers that it is able to provide products that consistently fulfil requirements."

ISO 9001 is intentionally generic to be applicable to organizations in any industry; however, several oil and gas industry-specific QMS standards have been developed, including:

- ISO/TS 29001: Petroleum, Petrochemical and Natural Gas Industries – Sector-specific Quality Management Systems – Requirements for Product and Service Supply Organizations [3];
- API Specification Q1: Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry [4]; and
- API Specification Q2: Specification for Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries [5].

ISO/TS 29001 is primarily the text of ISO 9001, with supplemental requirements for the oil and gas industry as necessary. Additionally, API Q1 and Q2 focus on manufacturers and upstream supply organizations, respectively. However, none of these specifications address specific QMS requirements for the pipeline construction industry. Due to this identified gap, PHMSA and DNV GL co-sponsored a project to develop a QMS framework for pipeline construction, as described in Section 4, below. This report is the result of this research and development effort.

3.3 QUALITY MANAGEMENT SYSTEMS IN THE PIPELINE INDUSTRY

Currently, many organizations employ quality assurance and quality control activities during the construction of pipelines, such as the use of specifications, personnel training programs, and inspections. However, many organizations lack a full QMS. Implementation of the systematic, process-based approach of a QMS improves a company's ability to identify, manage, and continually improve the activities and processes that affect the overall quality of a constructed pipeline. ISO 9000 [6] explains:

"The quality management system approach encourages organizations to analyse customer requirements, define the processes that contribute to the achievement of a product which is acceptable to the customer, and keep these processes under control. A quality management system can provide the framework for continual improvement to increase the probability of enhancing

customer satisfaction and the satisfaction of other interested parties. It provides confidence to the organization and its customers that it is able to provide products that consistently fulfil requirements."

The INGAA Foundation (INGAA) published a white paper [7] in 2012 which explored the benefits of applying QMS principles to the field implementation phase of pipeline construction projects. INGAA explained:

"A QMS does not guarantee a flawless product or service without defects, but provides a framework for maximizing the delivery of the product or service."

INGAA [7] went on to describe the application of QMS to pipeline construction activities in the following way:

"Thinking of a construction project as a collection of processes is central to the success of the QMS; a benefit being the QMS provides effective organization of the processes required to produce a conforming construction project, using a capable and efficient approach. The QMS is essentially a management tool that organizes work practices, which over time will lead to continual improvements in pipeline and station construction."

INGAA's white paper [7] also identified several benefits of implementing a QMS, including regulatory compliance and cost avoidance. While the development and implementation of a QMS will require additional up-front (prevention) costs, the return on investment, realized through reduced failures and re-work, will likely be equal to or greater than the implementation costs, as experienced in other industries. The "reduced failures and re-work" identified by INGAA can be considered increased safety and reliability of energy supply.

It should be noted that applying a currently developed QMS standard to pipeline construction may be difficult, as each pipeline construction project is unique. A risk-based and process-based approach must be adopted to allow a QMS to be used to manage the individual quality concerns for each pipeline construction project. Additionally, the main focus of QMS in some industries is on the consistency of components. In the pipeline construction industry, though, a QMS has the unique objective of promoting consistency, safety, and long-term integrity of the pipeline materials and components, as well as the construction, fabrication, and installation processes. Furthermore, a pipeline construction QMS can be integrated into a safety management system (SMS), and can be said, for example, to fulfil the requirement in Clause 8.3.2 of the draft API RP 1173, Pipeline Safety Management System Requirements [8]:

"8.3.2 Manufacturing and Fabrication

The pipeline operator shall maintain a quality control procedure to ensure that materials and construction are in accordance with the design and purchase specifications."

In July 2014, INGAA published Report No. 2104.04 [9], Guidelines for Practical Implementation of a Construction Quality Management System. Additionally, an American Petroleum Institute (API) task group was formed in 2015 to develop a recommended practice for pipeline construction QMS.

3.4 QUALITY CULTURE

For improvement of construction quality, a "quality culture" must be developed and fostered in the pipeline construction industry, including operating companies, manufacturers, suppliers, and contractors. A potential short-coming for quality in the industry is the constant struggle between quality, cost, and schedule. To see construction quality improve, quality should be elevated to the level of safety, at which time it would become acceptable and expected to stop work for a quality issue. Each person involved in the design, planning, materials procurement, construction, testing, and inspection of a pipeline should understand that they are responsible for verifying the quality and safety of their task and the overall pipeline; the "pass the buck" mentality that a later review or inspection will catch quality issues should be prevented. Additionally,

it should be reiterated that while the project team and construction personnel may go home safely, cutting corners with regards to quality may cause a safety or environmental issue in the future that was preventable.

4 PHMSA SPONSORED RESEARCH AND DEVELOPMENT PROJECT

In 2013, PHMSA solicited proposals for a research and development project titled, “Improving Quality Management Systems (QMS) for Pipeline Construction Activities” (DTPH56-13-RA-000002). Det Norske Veritas (U.S.A.), Inc. (DNV GL) was awarded this contract and co-funded the 16-month research and development effort.

DNV GL explored the feasibility of QMS in pipeline construction through a literature review and through interviews with oil and gas organizations, including representative operating companies, construction contractors, and industry organizations. In addition to the PHMSA Construction Team, the industry organizations contacted³ included: AGA, AOPL, API, Canadian Energy Pipeline Association (CEPA), INGAA, National Association of Pipeline Safety Representatives (NAPSR), Canadian National Energy Board (NEB), Pipe Line Contractors Association (PLCA), Pipeline Research Council International (PRCI), and Pipeline Safety Trust (PSTrust).

Following the information gained through these tasks, a QMS framework was developed for pipeline construction activities. The framework, and associated guidance document, is intended to assist pipeline operating companies, contractors, and suppliers in the development and implementation of a company-specific QMS for pipeline construction. The framework adopts a risk-based, process approach, as defined in other QMS and management system documents, and is designed to be scalable for a wide range of pipeline construction projects, including liquid and gas transmission pipelines and gas distribution lines. While gathering lines are outside of the scope of this project, a similar approach could be utilized to manage the quality on gathering line construction projects.

The framework and guidance document are contained in Appendices A and B, respectively. Additional information on the utilization of the QMS framework and guidance is found in Section 5 below.

5 PIPELINE CONSTRUCTION QMS FRAMEWORK AND GUIDANCE

The QMS framework (Appendix A) and guidance document (Appendix B) are intended to be used either as a stand-alone management system or as the quality component in a company’s corporate management system. It should be noted that the guidance document is a set of recommendations, suggestions, and examples that may be considered when developing the details of how to meet the requirements of the framework. The guidance information, which is identified in italics with a left side bar, is discretionary. In the future, it is PHMSA’s intent to incorporate requirements for pipeline construction QMS into the code of federal regulations (CFR) through additional CFR requirements or incorporation of suitable industry standards by reference.

For the purposes of this project, the scope of the QMS framework is shown in Figure 2, and includes materials procurement and inspection, construction, and pre-commissioning. Pipeline design and commissioning are outside of the scope.

³ Please note that not all of the industry organizations contacted chose to participate in the project.

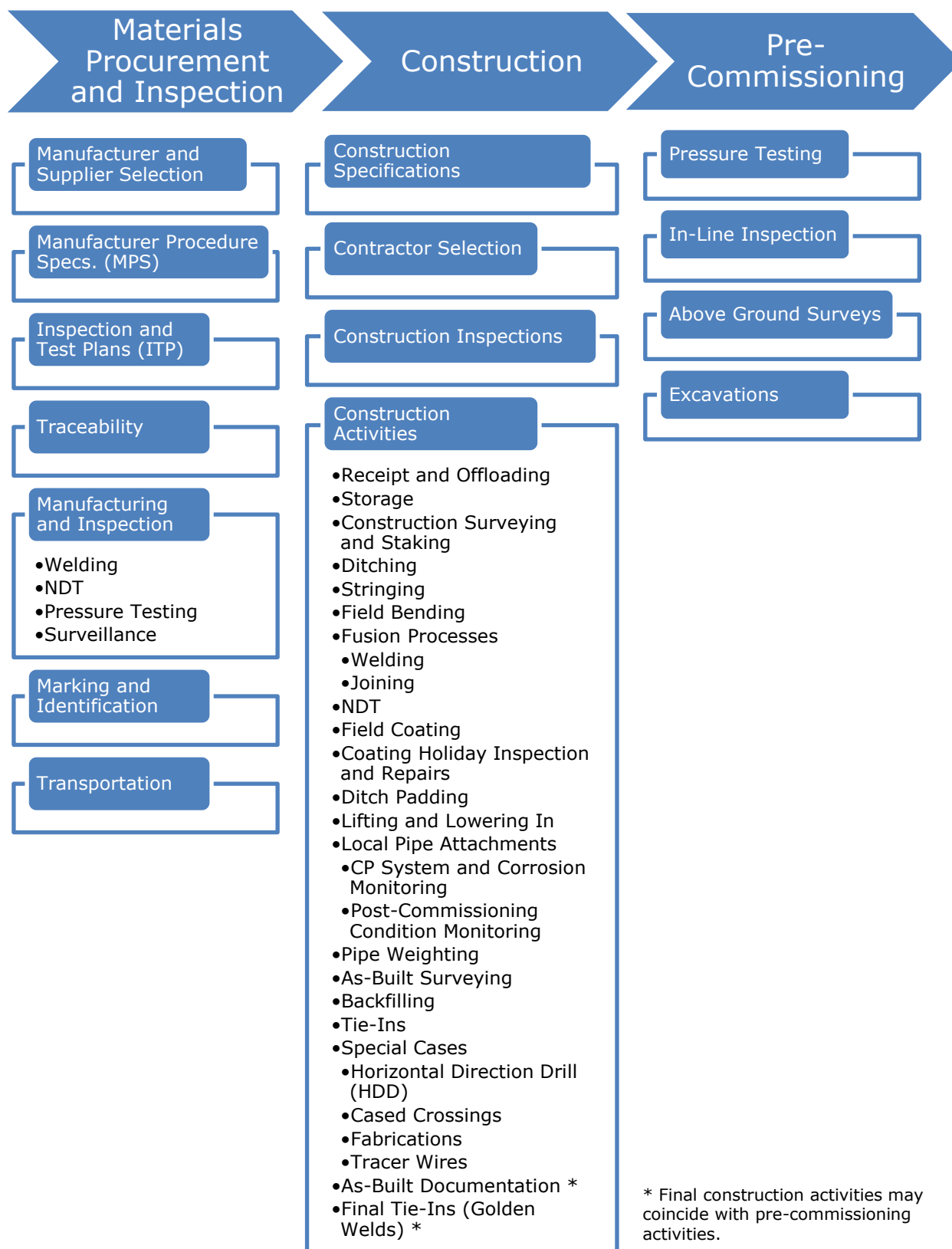


Figure 2. QMS Framework and Guidance Document Scope

5.1 PIPELINE CONSTRUCTION QMS DOCUMENTATION AND REVIEWS

The quality management of pipeline construction requires documentation at two levels: the QMS level and the project level. At the QMS level is the quality policy and the QMS manual, which includes the elements common to all management systems; examples include management reviews, management of change (MOC), resource management, and the continual improvement process. On the project level, the documentation includes the strategy documents and the procedures and work practices. The “strategy” documents are those that develop a strategy for how to achieve high quality in the project, including the project execution plans (PEP) and activity quality plans. Figure 3, below, shows these levels and the associated documentation. The project-level documents should be “managed” using the processes outlined in the QMS manual; examples include utilization of the MOC process for technical changes and the continual improvement process to update procedures if quality concerns are identified. Similarly, Figure 4 shows the multiple levels of review associated with the QMS and pipeline construction projects. Any quality issues or nonconformances identified should be elevated to the next level of review to be appropriately addressed.

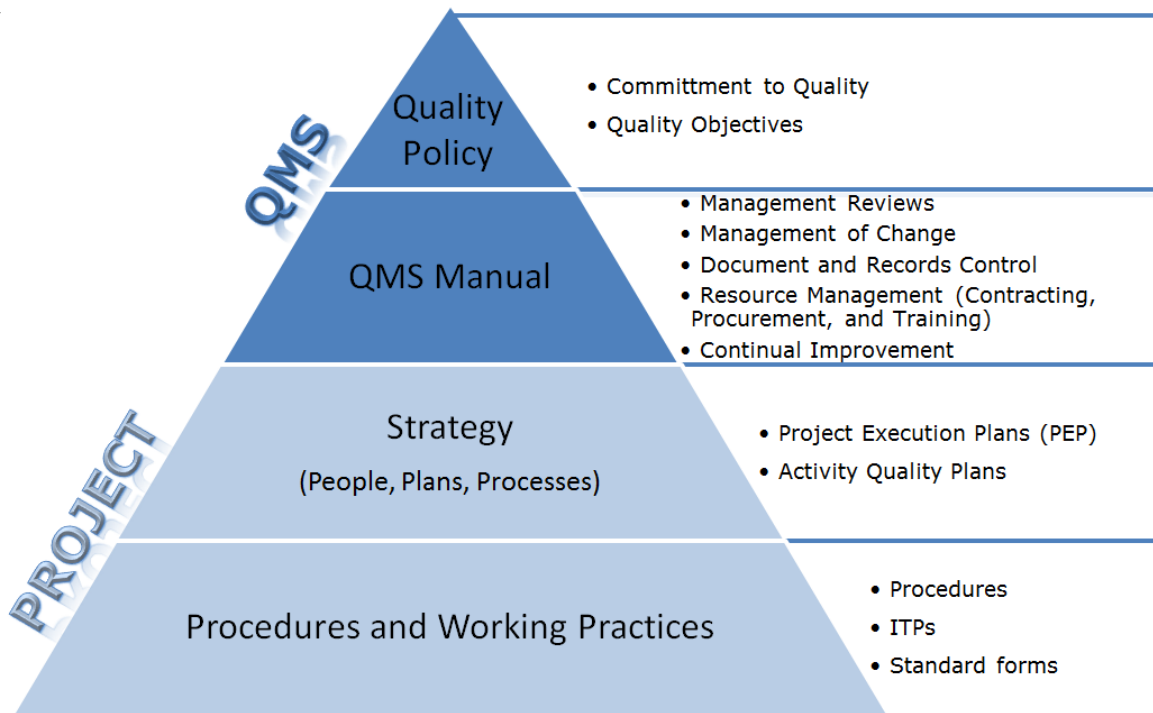


Figure 3. Quality Management Documents

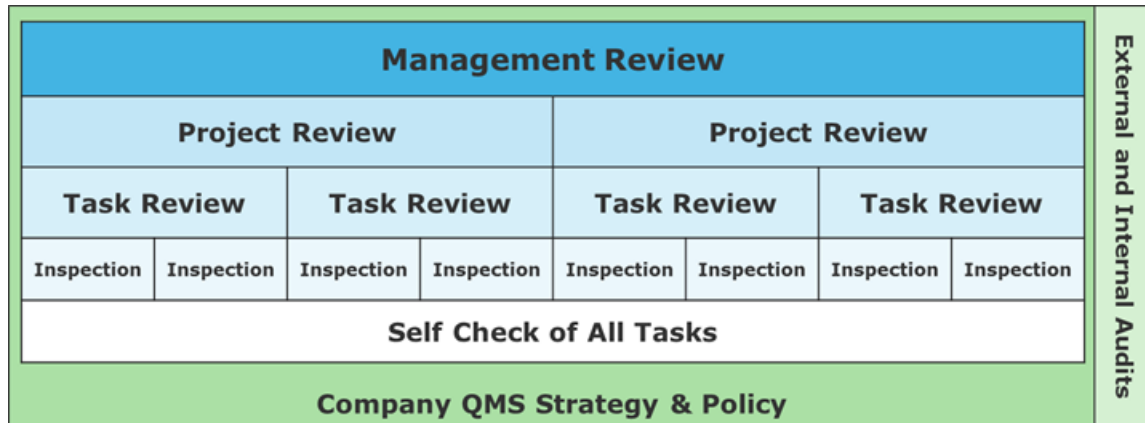


Figure 4. QMS and Project Reviews

5.2 DEVELOPMENT OF A QMS USING THE FRAMEWORK

To be applicable to the wide range of companies operating within the pipeline industry in the US, the framework was developed to be flexible and scalable. As stated previously, the framework can be utilized to develop or improve a stand-alone quality management system or as the quality component in a company's existing corporate management system, depending on the operating company's circumstances. Additionally, the QMS framework was developed for use by operating companies of varying size and scope. While the QMS elements will apply to each company, the application of these elements should be appropriate for the size of the operator, the scope of the project, and the risk to the public and environment.

Furthermore, although the guidance document covers typical pipeline construction activities, for which quality plans should be developed, each project is unique. Therefore, other construction activities may be relevant and should be addressed on a project by project basis, utilizing the principles of the QMS framework. Likewise, it is recognized that the identified construction activities may not be applicable to every pipeline construction project. It is the operating company's responsibility to consider unique quality issues applicable to their projects and address them accordingly through their company-specific QMS.

It should be noted that the quality practices of the operating company, materials suppliers, and construction contractors should all align. If the materials suppliers and construction contractors are responsible for providing the project documentation, it should be reviewed by all parties to verify compliance with the operating company's quality policy and QMS manual.

6 SUMMARY

Pipeline construction quality issues have been identified as a source of concern within the industry. To address these quality issues, PHMSA and DNV GL co-funded a project to develop a QMS framework (Appendix A) and guidance document (Appendix B). The principles behind these documents align with other widely accepted QMS standards, including ISO 9001 [2]. Previous work indicates that the up-front costs of implementing QMS in pipeline construction projects will be offset by the cost-savings of reduced failures and rework [7]. The pipeline construction QMS framework developed as part of this project directly ties back to deficiencies found via PHMSA inspections of construction activities and those as noted in a series of public events sponsored by PHMSA and others.

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APPENDIX A

QUALITY MANAGEMENT SYSTEM (QMS) FRAMEWORK

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1.0 INTRODUCTION

This document is a framework for a quality management system (QMS) for onshore pipeline construction projects. The QMS developed for onshore pipeline projects shall include and document the following, which are discussed in more details throughout this framework:

- Defined project quality objectives and personnel accountabilities;
- Processes to establish and maintain the appropriate project organizational structure;
- Processes to establish and maintain the appropriate competency of internal and contracted personnel;
- Processes to facilitate and verify quality throughout project design, contracting, procurement, manufacturing, fabrication, and construction;
- Processes to prevent, detect, mitigate, and eliminate near-misses and non-compliances with project procedures, specifications, regulations, and referenced standards, as well as verification and documentation of actions taken and the outcome;
- Assessment of the achievement of quality objectives throughout the construction project; and
- Methods to measure each process's effectiveness and enact continual improvement of the QMS.

The term "shall" indicates that a provision is mandatory, while the term "should" indicates that a provision is recommended. The company shall document the justification(s) for not following a recommended provision, as applicable.

2.0 SCOPE

This framework is applicable to construction activities that can affect the quality of onshore gas and hazardous liquid transmission and distribution pipelines, including activities from material procurement and inspection through pre-commissioning. Pipeline design and commissioning are considered outside of the scope of this document. The framework shall be used to aid in the development of a company-specific QMS.

3.0 TERMS AND DEFINITIONS

The following terms and associated definitions are utilized throughout this framework document¹.

- a) Audit - a systematic, independent, and documented process for obtaining records or information and evaluating it objectively to determine the extent to which a set of policies, procedures, or requirements are fulfilled.
- b) Complete - when describing records, able to be confirmed as finalized as evidenced by a signature, date, or other appropriate marking.
- c) Corrective Measure - an action taken to respond to the quality situation thereby limiting adverse consequences (i.e., actions taken to rectify an existing situation).
- d) Inspection - an evaluation for conformity by observation and judgment accompanied, as appropriate, by testing and/or measurement.
- e) Monitoring - a continuous, albeit not necessarily constant and complete, observation of parameters affecting the quality of a process. The intent of monitoring is to allow personnel, such as an inspector, to observe the activity or request performance data as needed.
- f) Preventive Measure - an action taken to eliminate the causes of a potential quality issue in order to prevent occurrence (i.e., actions taken to prevent a situation from occurring. For instance, actions arising from a risk assessment or near miss).

¹ Where applicable, definitions are aligned with those found in ISO 9000, Quality Management Systems - Fundamentals and Vocabulary.

- g) Project - a temporary endeavor undertaken to create a unique product, service, or result.²
- h) Qualification - an activity or process carried out to demonstrate that a procedure, material, or technology is able to fulfil specified requirements. This is typically associated with an extended volume and modified scope of testing, as compared to normal production.
- i) Quality Assurance (QA) - proactive, process-oriented activities, independent of production, with the goal of preventing quality issues. Examples of QA activities include audits, checklists, and the development of standards.
- j) Quality Control (QC) - reactive, product-oriented activities with the goal of identifying quality issues before work is finalized. Examples of QC activities include inspection and testing.
- k) Quality Event - any potential or actual issue that may affect quality. The following definitions further describe specific quality events.
- i. Near Miss - an event where quality was not affected, but had the potential to be affected. An example of a near miss is an inspector stopping an improper backfilling task as the machinery operator is about to commence. A near miss is often a situation or event that may not be known to others outside the activity or project. If not attended to at an early stage, near misses can develop into actual quality issues.
 - ii. Nonconformance - failure to follow a standard, specification, procedure, plan, etc., or non-fulfillment of a requirement contained in such document. An example of a nonconformance is field-bending a pipe to the wrong angle but recognizing the error prior to use of the bend during construction. Company representatives and contractors alike can commit nonconformances.
 - iii. External Complaint - a statement of dissatisfaction by an external customer (verbally or in writing) that the work or services provided do not meet the stated or implied needs or expectations of the customer.
 - iv. Audit Finding - a nonconformance, observation, or improvement opportunity identified during either internal audits or external audits conducted by third parties or auditors.
 - v. Incident - an undesired event that adversely affects quality. These could include damages or failures, failures to meet quality standards in the absence of damage, complaints that were caused by conformance to substandard procedures or specifications, or failures to comply with appropriate procedures or specifications. An example of an incident is lowering the pipeline into a rocky ditch and creating an unacceptable dent in the pipe.
 - vi. Improvement Proposal - an action identified by the operating company or suggested by an employee or contractor that may lead to an improvement in the company's quality standards, quality performance, or effectiveness of the QMS.
- l) Quality Management System (QMS) - A systematic approach designed to manage a company's objectives, policies, procedures, and processes with regards to quality. Quality is managed using four main activities: quality planning, quality assurance (QA), quality control (QC), and quality improvement.
- m) Quality Plan - a document specifying which procedures and associated resources shall be applied by whom and when to a specific process. For pipeline construction, a quality plan shall be developed for each construction task (stringing, welding, backfilling, etc.).
- n) Risk - the probability of an event and its associated consequence.
- o) Supervise - to observe and direct the execution of a process, activity, or task.

² From PMI's "A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Fourth Edition.

- p) Traceable – when describing records, able to be clearly linked to original information regarding a pipeline segment or facility.
- q) Verifiable – when describing records, able to confirm information by other complementary, but separate, documentation.
- r) Verification - an examination to confirm and communicate (or record) that an activity, product, service, or document is in accordance with specified requirements.
- s) Witnessing - the presence at and observation of a defined and specified event or test. Work shall not proceed until the inspector is available to witness the event. This is equivalent to a “hold point” in the production. The inspector may, however, in advance inform in writing or through a formal minute of meeting that his/her presence is not required.

4.0 ABBREVIATIONS

CFR	Code of Federal Regulations
CP	Cathodic protection
HDD	Horizontal directional drill
ITP	Inspection and test plan
MOC	Management of change
MPS	Manufacturer procedure specification
NCR	Nonconformance report
NDT	Non-destructive testing
PEP	Project execution plan
QA	Quality assurance
QC	Quality control
QMS	Quality management system
RFP	Request for proposal
TOR	Terms of reference
WPS	Welding procedure specification

5.0 GENERAL

5.1 Quality Management System

A QMS shall be developed, implemented, maintained, and continually improved by the operating company in accordance with this framework document. An operating company's QMS shall include requirements for suppliers, contractors, and subcontractors to verify that quality requirements are met, as applicable.

5.2 Approach

The development, implementation, maintenance, and continual improvement of a QMS shall be achieved using a “process approach” by performing and documenting the following:

- a) Identification of the project processes and construction activities that require management;

- b) Identification of the interactions between various project processes and construction activities;
- c) Determination of the criteria and methods required for the effective execution and monitoring of these processes;
- d) Determination of the resources required to execute and monitor the QMS processes, as well as the assurance of the availability of necessary resources;
- e) Measurement, monitoring, inspection, and analysis of these processes and construction activities; and
- f) Implementation of the activities required to achieve quality results and continual improvement.

Additional information regarding QMS project implementation is presented in Section 8.0, below.

5.3 Documents and Records

5.3.1 General

The operating company shall assemble, manage, and maintain the following major types of documentation and records:

1. Documented requirements for the ways in which the operating company expects each element of the management system to be met. These requirements may be included in a document such as a QMS manual or written management system and should include but may not be limited to the following:
 - a. QMS policy and objectives;
 - b. Roles and responsibilities;
 - c. Requirements of each QMS element outlined in this framework; and
 - d. Any additional company-specific requirements, as applicable.
2. Supporting documentation and records to demonstrate conformance with the QMS requirements, including:
 - a. Procedures;
 - b. Planning, operation, and process control documents; and
 - c. Records.

The operating company should perform a needs analysis to determine which records and documents shall be retained, both for regulatory or legislative reasons, as well as to conform to company requirements. In addition to maintaining records and documents, the operating company shall store the information in an appropriate manner, i.e., in a format that allows usability, reliability, authenticity, accountability, and preservation, thereby confirming they are 'traceable, verifiable, and complete'.

5.3.2 Control of QMS Documents

The operating company shall establish procedures for the control and dissemination of QMS documents, including:

- Identification of documents that are required for the effective implementation of the QMS;
- Identification and review of documents that require access control and/or distribution control;
- Approval of documents, including assurances of legibility and accessibility;
- Identification of the current revision of each document, including procedures for removal of obsolete/invalid documents from circulation and use; and
- Maintenance of documents, including back-up and archival of critical or obsolete documents.

5.3.3 Control of Records

The operating company shall establish procedures for the control of records that demonstrate compliance with and the effectiveness of their QMS. Such records are generated as part of the QMS process and shall be identified, organized, and retained. It is recommended that such records be maintained for the life of the pipeline or project.

5.4 Management of Change

The QMS shall include a Management of Change (MOC) process to control, evaluate, verify, and validate technical and administrative (non-technical) changes to the design, contracting, procurement, manufacturing, fabrication, and construction of new pipelines, as well as changes to the QMS itself. Each MOC request must be approved prior to implementation. The review of such changes shall include evaluation of the effect each change or suite of changes can potentially have on construction quality.

5.4.1 Managing Administrative Changes

Changes to the written QMS document, as well as other associated administrative processes, procedures, and requirements shall be managed to determine the effects they may have on quality of new pipeline construction.

When managing changes to the written QMS, the requirements for Continual Improvement, discussed in Section 9.0, below, shall be followed as outlined in the QMS document. In addition, the effect the change may have on the organization's risk profile, risk tolerance, quality philosophy, and other corporate standards shall be evaluated with the change.

5.4.2 Managing Temporary Changes and Exceptions

The QMS shall include requirements for managing temporary changes to construction practices, temporary exceptions to the QMS requirements, and exceptions to specifications. Although temporary in nature, these changes shall be evaluated to determine if they present a risk to the quality of the pipeline's overall construction, integrity, operation, personnel safety, or environmental safety.

5.4.3 Learning from Events

Following continuous improvement activities from quality events, such as external complaints, incident investigations, near misses, nonconformances, audits, improvement proposals, or planned assessments, the organization may suggest changes to improve the QMS or quality management processes for pipeline construction projects. Prior to the implementation of suggested changes on currently on-going projects, the MOC process, as described in Section 5.4, shall be utilized to minimize the likelihood that the change will adversely affect the quality of the pipeline construction project.

6.0 MANAGEMENT RESPONSIBILITY

6.1 Owner Company Responsibility

The owner company, as the entity who is funding the construction and may operate the pipeline, has the ultimate responsibility for the quality of the finished assets including:

- Conformance to regulations;
- Conformance to standards of the industry;
- Conformance to company specifications; and
- The ability of the pipeline and associated facilities to perform the intended function on a sustained basis in a safe and environmentally sound manner.

In addition to legal requirements, owner companies require public acceptance and trust (sometimes referred to as "privilege to operate") in order to operate effectively due to the possible severe consequences of failure. In order to define and communicate the standard of care to be achieved, companies have the responsibility to set guiding principles, typically in the form of publicly expressed values statements.

When utilizing contractor services, the owner company shall verify the QMS and associated project specifications/requirements are followed by the contractor.

6.1.1 Management Commitment

Management shall commit to developing, implementing, and continually improving the effectiveness of the QMS by:

- Establishing the quality policy and its objectives;
- Communicating to the entire organization the importance of meeting all statutory, regulatory, and company requirements;
- Maintaining documented approval and support of the QMS by company management;
- Conducting management reviews;
- Confirming the availability of resources;
- Preventing conflicts between project cost/schedule and quality; and
- Identifying and documenting company requirements in applicable orders, contracts, and specifications.

6.1.2 Policy

The Company shall establish a Quality Policy. The Quality Policy describes the company's intentions with regards to managing quality utilizing a QMS; it shall:

- Be appropriate for the purpose of the organization and aligned with the company values;
- Provide for a framework for establishing and reviewing quality objectives;
- Be managed through a management review process;
- Be communicated and understood within the organization;
- Be reviewed on a regular basis for continuing suitability; and
- Have documented approval by company management.

6.1.3 Communication

Communication processes must be established which facilitate awareness, understanding, and acceptance of the QMS and associated processes and procedures throughout the organization, as well as by contractors and other external stakeholders. Critical communications that require action shall be tracked through completion.

6.1.3.1 Internal Communication

Internal communication processes link management, employees, and other internal stakeholders. The attainment of the quality goals depends on successful communication. The communication process shall allow for employees to give feedback and provide possible solutions to issues.

Key communication processes include:

- Establishment, communication of, and adherence to best practice;
- Learning opportunities from ongoing activities, near-misses, and incidents;
- Effective MOC communications; and
- Clear communication of roles, authorities, and responsibilities.

6.1.3.2 External Communication

The external communication process shall include:

- Sharing of company requirements and expectations;
- Sharing of best practice;
- Learning opportunities from ongoing activities, near-misses, and incidents;
- Key contacts and elevation plans for technical and non-technical inquiries; and
- Approval processes for subcontracting or other contractual changes.

6.1.4 Organization

6.1.4.1 Responsibilities and Authorities

The responsibilities and authority of each role in the organization with respect to the QMS or construction project shall be defined and documented. The responsibilities and authorities for each role shall be communicated throughout the organization to promote awareness.

6.1.4.2 QMS Management Representatives

A management representative shall be appointed within each appropriate organizational unit to:

- Promote the establishment, implementation, and maintenance of processes needed for the QMS;
- Apply lessons learned from previous projects;
- Communicate to management regarding the performance of the QMS and need for improvement with regard to their organizational unit; and
- Facilitate the promotion of awareness within the organization as a whole.

6.1.4.3 Avoiding Conflict of Interest

Management shall have procedures and policies in place to both recognize the potential for conflict of interest and to minimize the likelihood that quality objectives are affected by conflict of interest.

6.1.5 Management Review of QMS

6.1.5.1 General

A management review shall be defined and carried out at the frequency necessary to promote the continuing effectiveness of the QMS, examine current issues, and assess opportunities for improvement. Additionally, continual improvement activities, conducted by individual or cross-functional groups, shall be reviewed. Management reviews shall be documented.

6.1.5.2 Review Input

The management review input shall include information relative to the performance of the QMS and detection, mitigation, and resolution of quality issues. In addition, the review shall consider the potential effect of external influences on quality requirements.

6.1.5.3 Review Output

The output from the management review shall include any actions related to:

- Verification and documentation of corrective and preventative measures taken or planned;
- Reallocation or supplementing of resources;
- Redefinition of responsibilities or changing organizational details;
- Changes to procedures and/or documentation practices to meet changes in company specifications and/or regulatory requirements;
- Changes to policy; and
- Setting new quality objectives and initiating actions to improve the QMS, processes, and products.

6.2 Contractor and Supplier Responsibility

When required by the operating company, contractors and suppliers to the operating company shall have their own QMS which is aligned with that of the operating company's QMS.

Additionally, the contractors and suppliers shall be responsible for the quality of their supplied products or services, including:

- Conformance to regulations;
- Conformance to standards of the industry; and

- Conformance to applicable specifications and company requirements.

6.2.1 Contractor and Supplier Management Commitment

Contractor and supplier management shall commit to implementing and continually improving a QMS which supports and is aligned with the client's QMS by:

- Verifying that customer requirements are identified and are well understood by careful review of the order, contract, and specifications;
- Establishing the quality policy and its objectives;
- Communicating to the entire organization, including any subcontractors, the importance of meeting client requirements as well as all statutory, regulatory, and company requirements;
- Preventing conflicts between project cost/schedule and quality;
- Conducting and documenting formal management reviews to verify the policy's continuing suitability and effectiveness and responses to identified deficiencies or nonconformances; and
- Verifying that resources required to satisfy the quality requirements of the client procedures and specifications are available and provided.

6.2.2 Contractor and Supplier Policy

The Quality Policy shall:

- Be appropriate to purpose for the organization and aligned with the company and client organization values;
- Be managed through a process including management reviews on a regular basis to verify its continual suitability;
- Set the requirements for the QMS and continuously improve its effectiveness through monitoring and measurement;
- Provide for a framework for establishing and reviewing quality objectives;
- Be communicated and understood within the organization and by client organizations; and
- Be capable of addressing the quality requirements of various pipeline operator organizations recognizing that there could be significant differences among the policies and specifications for each operating company.

6.2.3 Communications

The communication process for contractors and suppliers shall promote effective communication with both the designated representative(s) of the pipeline operator and within the contractor or supplier organization to facilitate timely communication, understanding, and performance of the project requirements.

6.2.4 Contractor and Supplier Organization

6.2.4.1 Responsibilities and Authorities

Contractors and suppliers should share a complete description of their relevant organizational structure with the pipeline operating company. All roles, together with personnel who hold the roles, with the responsibility to manage, perform or verify work affecting quality should be specifically identified.

6.2.4.2 Management Representative

The contractor or supplier should have a management representative, a designee in a senior position whose duties include the primary responsibility for verifying that the quality-related aspects of the task or project are met.

6.2.4.3 Avoiding Conflict of Interest

Supplier and contractor management shall have procedures and policies in place to both recognize the potential for conflict of interest and to minimize the likelihood that quality objectives are affected by conflict of interest.

6.2.5 Contractor and Supplier Management Review of QMS

6.2.5.1 General

A management review shall be defined and carried out at the frequency necessary to verify the continuing effectiveness of the system, examine current issues, and assess opportunities for improvement. Additionally, continual improvement activities, conducted by individual or cross-functional groups, shall be reviewed. Management reviews shall be documented.

6.2.5.2 Review Input

Management review shall consider inputs relevant to the organization's conformance to the QMS, external changes that could influence the QMS or quality requirements, and any identified deficiencies in the QMS.

6.2.5.3 Review Output

The output from the management review shall include any actions related to:

- Verification of corrective and preventative measures taken or planned to address nonconformances reported by internal staff;
- Corrective and preventative measures taken or planned to address nonconformances reported by the pipeline operator;
- Reallocation or supplementing of resources;
- Redefinition of responsibilities or changing organizational details;
- Changes to procedures and/or documentation practices to meet changes in client specifications and/or regulatory requirements;
- Changes to policy; and
- Setting new quality objectives and initiating actions to improve the QMS, processes, and products.

7.0 RESOURCE MANAGEMENT

7.1 Provision of Resources

The operating company shall determine the resources required to develop, document, implement, manage, supervise the application of, and continually improve the QMS.


7.2 Human Resources

7.2.1 Training and Competency

The operating company is responsible for developing, documenting, implementing, managing, supervising, and continuously improving a program that trains personnel to meet the requirements of the QMS and other applicable company standards, specifications, and regulations in a safe and environmentally responsible manner. Applicable training and competency requirements shall be applied to both operating company personnel and contractor/supplier personnel responsible for the QMS system and for all stages of pipeline construction projects, including design, planning, materials procurement, construction, testing, and inspection. The training and results of competency testing shall be documented and retained for at least as long as the life of the systems on which the employee has worked or for the duration of the contract or employment period, whichever is longer.

7.2.2 Contractor Services

The operating company shall develop, document, apply, and refine processes at specified intervals to verify that contractor services meet or exceed the quality standards of the QMS. If necessary, the specified intervals may be reduced to address unexpected deficiencies or nonconformances. Contractor selection processes shall include, but not be limited to, comparison between the demonstrated capabilities (rather than claimed capabilities) of the contractor and the applicable requirements of the QMS. Furthermore, the



evaluation shall consider the contractor's demonstrated ability to meet the applicable quality standards while working in a safe and environmentally sound manner.

The same considerations should be applied to the qualification of any subcontractors used by the contractor. The contractor shall be responsible for verifying the subcontractor meets the quality standards set forth in the owner company's QMS. The operating company shall designate the process by which subcontractors will be identified, reviewed, and approved, as applicable. Additionally, the contractor shall be responsible and accountable for any deficiencies in deliverables generated by the subcontractor regardless of the approved use of the subcontractor by the operating company.

The operating company shall define and document performance standards and communicate those to the contractor. The contractor and operating company shall jointly define a suitable method and frequency of audits and performance monitoring and the manner in which the contractor will support the monitoring and assessment of contractor performance.

7.3 Infrastructure

The operating company shall have ultimate responsibility to identify, provide, and maintain the infrastructure required to support the effective implementation of the QMS.

7.4 Work Environment

The operating company shall identify and manage the environmental, human, organizational, and security factors of the project working conditions that could inhibit the ability to meet the requirements of the QMS.

8.0 QMS PROJECT IMPLEMENTATION

8.1 General

Section 8.0 describes the project activities that directly support effective implementation of the QMS. Formal procedures and practices applicable to each core process include consideration of the following topics:

- Description of the objective;
- Identification of the responsible and accountable organizational element;
- Identification of resource requirements including training, qualification, or certification requirements for company staff, contractors, manufacturers, or suppliers, where applicable;
- Documentation and record keeping;
- Management of change;
- Review and validation practices to verify consistency with applicable regulations, standards, and company policy and procedures;
- Objective performance measurement targets and measurement methods; and
- Scope and frequency of inspections and audits to verify that the objectives are being met, with feedback to a continuous improvement process.

8.2 Project Quality Risk Management

The operator shall identify the risks, or probability of quality events and their consequence, associated with failure to meet the objectives of each core process. Risks should be managed through monitoring, controlling, or minimizing the probability and/or consequences. Effective project quality risk management relies upon the ability to identify potential sources of deviations or deficiencies and then to develop strategies to prevent or mitigate each. While procurement, manufacturing, fabrication, and construction tasks are required for each project, the associated QA/QC requirements for each may be scaled, as described in Section 8.3, below.

8.3 QMS Scalability

The quality management requirements for each project shall be commensurate with the identified project quality risks and complexity.

8.4 Pre-Construction Considerations

8.4.1 Planning and Review

The pre-construction planning process shall include consideration of, but is not limited to the following:

1. Regulatory and statutory requirements;
2. Permitting processes;
3. Anticipated land use;
4. The expected normal operating conditions;
5. The likely upset conditions or unexpected excursions in operating conditions;
6. The compatibility of pipe and components with the product to be transported;
7. Anticipated testing and inspection protocols, including during construction and during operation;
8. Pipeline marking, one-call registration (including pipeline siting and contact information), and emergency-responder communication processes and timing;
9. Post-commissioning protection of the pipe, including a properly designed corrosion mitigation system, a cathodic protection (CP) system, as applicable, damage prevention measures, as applicable, and any elective post-commissioning monitoring;
10. Identification of expected integrity threats and understanding of applicable prevention and mitigation methods;
11. Identification of any special environmental considerations, that raise the risk associated with a failure of the pipeline or may impact frequency of access to the pipeline;
12. Identification of crossings and HDDs to understand materials requirements and scheduling impacts;
13. The likelihood that contractor resources in the local geographic area can be matched with the resources required to produce the deliverables;
14. The need for materials testing before the materials are selected and the time required for the testing, if materials and service conditions are outside of current expertise;
15. The lead time required to procure, inspect, and accept project materials after material selection and design decisions are made; and
16. The project completion date.

The findings for each applicable consideration shall be documented to facilitate review either after the project completion or after some time of pipeline operation to determine if the pre-construction planning process was reasonably effective, as applicable. The retention period shall be established by the operating company.

8.4.2 Regulatory and Statute Requirements

Contractors and suppliers shall be informed of the applicable regulatory and statute requirements, and are responsible for meeting all applicable requirements.

8.4.3 Additional Requirements

The company is responsible for imposing additional requirements that supplement regulatory or statute requirements to verify that the appropriate level of quality is obtained and that the design is suitable for the intended service conditions. Contractors and suppliers shall be informed of the applicable company requirements and are responsible for meeting these requirements.

8.4.4 Design Control and Verification

The operating company shall develop, document, and apply design control procedures. The design control procedures shall not be limited to design of the pipeline itself. The control procedures shall also cover all associated components, equipment, systems, or other items that will affect the integrity of the pipe and system.

8.5 Contractors and Suppliers

Contractors and suppliers shall meet the specified quality standards. Additionally, the operating company shall verify that selected contractors and suppliers have the resources and commitments to meet specified quality standards and that the deliverables from those contractors and suppliers do, in fact, meet the specified quality standards. To support that goal, the operating company shall develop and apply a contractor and supplier qualification process, supplemented by an appropriate level of in-process audits and verification of quality. The qualification process and in-process audits may be performed by appropriate subject matter experts of the operating company or may be supplemented with or delegated to appropriate independent contractors. The extent of the qualification and audit processes shall be commensurate with the relationship of the deliverable to the success of the project and the risk of receiving substandard deliverables. The frequency and scope of the audits should be modified to reflect observed performance and quality.

The operating company shall also specify content to be included in request for proposals (RFPs), bids, purchase orders, and other the procurement documentation to verify that appropriate emphasis on quality is included and that appropriately detailed records of the contractor or supplier selection and material and services procurement process are maintained.

8.5.1 Approved Vendor List

If approved vendor lists are utilized, modifications shall follow the MOC process, as described in Section 5.4, above.

8.5.2 Bid Process and Evaluation

If a bidding process is utilized, the quality policy, objectives, and metrics for the project shall be communicated to all prospective bidders as part of the initial RFP.


Bidding companies shall be required by the RFP to clearly differentiate third party roles and responsibilities including inspection, non-destructive testing (NDT), and/or surveillance.

Evaluation of the quality aspects defined by the company shall be included in the review of bids. At a minimum, the contractors'/suppliers' inspection and test plans (ITPs) for the various activities undertaken during their scope of work for the pipeline shall be reviewed for adequacy, as well as the ability of each contractor/supplier to competently execute the ITPs. Additionally, the use of subcontractors shall be indicated in the contractor's proposal and details of how the verification of subcontractor's quality shall be shown.

8.5.3 Exceptions and Contract Terms

Exceptions to the company's scope of work, specifications, schedule and/or contract terms and conditions shall be clearly identified. Exceptions raised following award of the contract shall be handled by the MOC process, as described in Section 5.4, above.

The contract terms shall cover the quality aspects defined by the company. Re-work responsibility shall be addressed. Additionally, the contract terms shall address the required processes and approvals for subcontracting work.



Additionally, the contract terms shall address the communication process. Communication of the QMS, project specifications, design standards and related material shall be specified in the contract documents to enable all parties involved in the construction process to have access to the materials necessary to facilitate a successful project. Changes to the QMS or project specifications shall be managed through the MOC process, as described in Section 5.4, above, to facilitate communication to all stakeholders.

The communication process, as defined in the contract terms, shall enable the prompt communication of any identified quality issue, root cause, contributing factor(s) and required remedial action to affected stakeholders to facilitate identification and mitigation of potential issues throughout the project.

8.5.3.1 Risk sharing and Warranties

The use of risk sharing contracts shall not substitute for adequate financial qualification of contractors or substitute for the owner/operator's responsibility to inspect and accept the finished product. Additionally, Warranties shall not be considered a replacement for inspection and verification during construction.

8.5.4 Project Execution Plans

A Project Execution Plan (PEP) shall be prepared by each supplier or contractor, when required by the operating company, and shall include how the operating company's QMS will be applied to the project. The format and level of detail in the PEP shall be commensurate with the level of risk related to the product or service, at minimum. The PEP shall also demonstrate compliance with applicable regulatory and statute requirements and company specifications. The PEP should cover all activities required to complete the work scope. Additionally, the PEP should include an individual quality plan for each supply, deliverable, or construction activity.

The owner company shall be responsible for reviewing the PEP and individual quality plans for compliance with the QMS and other applicable requirements. Following review and approval, the applicable quality plan shall be provided to all responsible parties, including applicable field personnel, to enable project activities to be performed in accordance with the requirements of the QMS and PEP.

8.6 Project Management

8.6.1 Organizational Stakeholders

All organizational units with an appointed management representative, as described in Section 6.1.4.2, above, shall also appoint a representative for each construction project, as applicable. The organizational stakeholders required for each project shall be commensurate with the identified project quality risks and complexity.

8.6.2 Planning

The deliverables of the project planning process may consist of a specification of the individual tasks, the project execution plan (PEP) and associated individual quality plans, schedules, including critical paths, budget, and labor and non-labor resources needed to achieve the project objectives. Elements of the planning process may be waived by the operating company for tasks deemed as low risk.

8.6.3 Project Change Control

Changes and modifications to the PEP(s) shall be documented and communicated in accordance with the established MOC process, described in Section 5.4, above.

8.6.4 Project Review

The operating company shall designate the format and frequency of project reviews, and shall include relevant suppliers and contractors. The frequency may correspond with the achievement of certain significant milestones or may be made at convenient intervals of time irrespective of milestones.

8.7 Materials Procurement and Inspection

When required by the operating company, contractors and suppliers to the operating company shall have their own QMS which is aligned with that of the operating company's QMS. Where materials or goods are purchased on behalf of the operating company by a third party, the operating company's QMS shall be transferable and adopted by the purchaser. In addition to the QMS, manufacturing processes require additional process documentation, review, and control to facilitate meeting the required quality, schedule, delivery, and overall project objectives including performance specifications and regulatory requirements. This section is applicable to pipe manufactures, pipe coaters, double jointers, component manufactures, and other parties who provide materials or products, rather than services.

For pipelines subject to federal pipeline regulations, if used pipe is utilized on the project, it must meet the requirements of 49 CFR 192.55(b) or 49 CFR 195.114, as applicable.

8.7.1 Development of Manufacturer Procedure Specifications (MPS)

When required by the operating company, the supplier shall provide a manufacturer procedure specification (MPS) detailing manufacturing processes, quality assurance methods, quality control activities inclusive of hold points, and a description of applicable geometrical checks, material testing, and NDT. The MPS should be evaluated prior to the start of production for conformance with customer specifications, industry standards, and the intended service of the product (sour, high temperature, arctic, etc.). Exceptions to the specification taken by the supplier shall be carefully considered to assess the likelihood that the final product performance will meet the project criteria.

The MPS should clearly identify the suppliers of raw materials, consumables, and component parts, and the quality management practices utilized during the production of these materials. The MPS should also detail the requirements for and documentation provided by raw material, component part, and consumable suppliers in support of the manufacturer's QMS.

The MPS shall give consideration to the set-up and calibration of NDT equipment and measuring instruments used during the manufacturing process. Set-up and calibration procedures shall be established for all NDT equipment utilized during production. Corresponding personnel qualification requirements shall be listed for each operation. In the event the manufacturer utilizes NDT, measuring instruments, and/or material testing for production control, information, and/or raw material verification, the MPS shall specify the level of inspection and distribution of the results.

8.7.2 Development of Inspection and Test Plans (ITP)


When required by the operating company, materials manufacturing tasks shall have an inspection and test plan (ITP) developed to establish activities or processes subject to monitoring, documentation review, when witnessing or verification activity is required, when testing of the product is required, or when a hold is required for production to wait for authorization to proceed.

8.7.3 Manufacturing Traceability

Consideration shall be given to recording the unique identification of each manufacturing component, raw material, and/or consumable. Individual identifiers may be consolidated under a single identifier utilizing an appropriate tracking system. Quality control documentation such as pressure test data, NDT results, test pieces, and mechanical and metallurgical test results shall be traceable to the finished goods.

8.7.4 Materials Inspection

Material inspection and testing requirements are specified in the MPS and ITP specific to the material being manufactured and the manufacturing process. All necessary witnessing, verification, testing, and documentation review shall be completed and accepted prior to the material or product being classified as finished goods and released to the project.



The manufacturer shall verify that raw material, parts and consumable suppliers under their control have the resources and commitments to meet specified quality standards and that the deliverables from those suppliers do, in fact, meet the specified quality standards.

Material testing facilities and equipment should be identified in the MPS and ITP prior to the start of testing.

8.7.5 Welding Inspection during Manufacturing

All welding geometries, parameters, and consumables shall be detailed in a Welding Procedure Specification (WPS) and approved by the purchaser prior to the start of manufacturing. Procedure Qualification (PQ) tests shall be documented prior to the start of manufacturing and essential variables monitored throughout production. Welding procedures shall be re-qualified following any change in essential variables and under any other conditions designated by the operating company. Double jointing operations shall be performed in accordance with Section 8.8.3.7.1 Welding, below.

8.7.6 Non-Destructive Testing during Manufacturing

Nondestructive testing shall be in accordance with the MPS and ITP.

8.7.7 Pressure Testing during Manufacturing

Calibration and test records shall be distributed and retained in accordance with the purchaser's specifications, MPS and ITP. Units of measure shall be specified prior to production and chosen to provide sufficient resolution to achieve the desired level of accuracy.

Where pressure testing of a prototype or production piece is used in lieu of full production run testing, the manufacturer must certify the component was manufactured under a quality control system that verifies that each component is at least equal in strength to a prototype that was hydrostatically tested at the factory. The MPS shall include provisions to facilitate and verify quality through all production stages and monitoring of critical production steps such as casting, forging, and/or assembly of equipment. Where seals, plugs or other devices are used that could affect the serviceability of the equipment, clear documentation and installation procedures shall be provided to the end user concurrent with or prior to delivery.

8.7.8 Surveillance during Manufacturing

Manufacturing surveillance may take the form of monitoring, witnessing, or verification. The surveillance plan shall be clearly communicated to the manufacturer prior to the start of production. Surveillance personnel shall have the requisite experience and knowledge to interpret and evaluate manufacturing and testing requirements, equipment, and results. Consideration shall be given to adequate access to manufacturing facilities, production records, and test results for inspectors and purchaser representatives during all phases of production, as applicable.

8.7.9 Manufacturing NCRs and Dispositions

The manufacturer shall have a QMS established that addresses the identification and disposition, such as repair or disposal, of raw materials, pipe, or components that do not conform to the purchaser's specifications. Nonconformance reports (NCR) may be initiated by the manufacturer, the purchaser, or the purchaser's representative (inspectors). NCRs shall be made available to the purchaser or the purchaser's representative during and following production. NCRs shall contain sufficient detail to allow for the identification, disposition, and tracking of systemic situations and other potentially impacted materials. The manufacturer shall have processes for quarantine, marking, and segregation of non-conforming materials. Non-conforming materials shall not be identified as finished goods to avoid accidental shipment to the project.

8.7.10 Manufacturing Marking and Identification

Marking schemes should be established prior to material procurement to provide for traceability and coordination between the various project parties. Supplemental marking shall be clearly visible, weather and transportation resistant, and compatible with coatings.

8.7.11 Transportation and Handling

The MPS shall include shipping and handling instructions specific to the mode(s) of transportation, lot size, and intermediate transfer points if applicable. Where shipping seals, plugs, packing or other devices are used that could affect the serviceability of the equipment, clear documentation and installation procedures shall be provided to the end user concurrent with or prior to delivery.

8.8 Construction

8.8.1 Control of Construction and Inspection

The operating company shall plan, perform, and monitor construction of the pipeline system in accordance with established company procedures, PEPs, and individual quality plans. The procedures shall address and promote the availability and use of:

- Drawings, documents, and specifications;
- Suitable materials obtained from qualified manufacturers and suppliers;
- Qualified service providers;
- Effective inspection, testing, and quality control procedures, including documentation practices and the availability of related inspection, testing, and monitoring equipment; and
- Pre-commissioning procedures.

8.8.2 Field Identification and Traceability

Consideration shall be given to recording the position and unique identification of each system component.

8.8.3 Quality Plans for Construction and Installation Activities

A specific quality plan shall be developed for each construction activity performed on the project. Refer to section 8.5.4, above, for additional information on individual quality plans. Examples of construction activities include:

- Receipt and offloading;
- Storage;
- Construction surveying and staking;
- Ditching;
- Stringing;
- Field bending;
- Fusion processes, including welding or joining of plastic pipe, as applicable;
- Non-destructive testing of welds;
- Field coating;
- Coating holiday inspection (jeeping) and coating repairs;
- Ditch padding;
- Lifting and lowering-in;
- Local pipe attachments, including the cathodic protection (CP) system and CP monitoring, and post-commissioning condition monitoring, as applicable;
- Pipe weighting;
- As-built surveying;
- Backfilling;
- Tie-ins;

- Special considerations, including horizontal direction drilling, cased crossings, on-site or off-site fabrications, and the installation of tracer wires for locating plastic pipe;
- Pre-commissioning pressure testing;
- Pre-commissioning inspections, surveys, and excavations;
- Final tie-in welds; and
- As-built documentation.

It is the responsibility of the operating company or construction contractor to identify any additional or unique activities for the company's project, as applicable. Not all of the examples are applicable to every project; some may be required by regulation while others are discretionary and may only be applicable to some high-risk projects.

9.0 CONTINUAL IMPROVEMENT

9.1 General

Organizations shall plan, manage, and take appropriate measures to enable the continual improvement of the QMS as well as associated procedures and processes. Both the effectiveness of the QMS and its continued relevance to the organization's corporate goals and objectives shall be evaluated through this process. Improvements may take the form of changes to the overall policy, the corporate objectives for quality, as well as the individual elements of the QMS and their associated processes and procedures.

9.2 Management Review and QMS Audits

The effectiveness of the QMS shall be continually reviewed and improved through systematic management reviews and audits of the QMS. The processes to be used for each of these activities shall be documented as part of the QMS, along with requirements for re-assessment intervals. The outputs of management reviews and QMS audits shall include documented approval by company management.


9.2.1 Management Review

Management Reviews shall be undertaken as set out in Section 6.1.5 of this document and should be carried out in a way that will verify the following:

1. The Quality Policy still reflects the organization's position on maintaining quality during the design and construction phases;
2. The Quality Objectives continue to support the overall corporate objectives;
3. The QMS reflects current regulatory requirements and recognized and generally accepted good industry practices;
4. Management supports the QMS;
5. Management reviews are conducted at a defined frequency, and actions are undertaken to address findings;
6. Data are analyzed in a way that will identify trends and facilitate an appropriate response to quality issues;
7. Previous QMS audit action items have been closed or are in the process of being addressed;
8. The organization is in conformance with the QMS;
9. The effectiveness of the QMS is being evaluated;
10. Management Review minutes are circulated to appropriate personnel; and
11. The MOC process is used to facilitate the appropriate management of changes to the QMS.

9.2.2 QMS Audit

An audit process shall be in place to verify that the organization is evaluating the performance of the QMS. For each QMS audit, a written plan or document may include the scope of the audit, people or positions to be interviewed, checklists or listing of documents to be reviewed, and other relevant information that will



enable the auditor/audit team and audit organizer to have a common understanding of the audit's purpose. This information may be stated in a "terms of reference" (TOR) document, proposal, audit protocol, or similar and should be fit for purpose, as determined by the scope and scale of the audit.

The QMS can also be evaluated in its entirety or by element; however, during each audit cycle, the QMS audits shall determine, at a minimum, if the following are occurring:

1. The Quality Policy is understood throughout the organization;
2. Staff understand their role in achieving the Quality Objectives;
3. The written QMS is comprehensive and relevant to the organization's business and assets;
4. The requirements of the QMS are being met as intended;
5. Quality audits are conducted on a regular basis, and actions are undertaken to address findings;
6. Preventive actions are taken to minimize the likelihood of foreseeable quality issues;
7. Corrective actions are taken to minimize the likelihood of a similar quality issue being repeated;
8. Quality issues are being addressed in a timely manner;
9. Lessons learned and quality concerns are circulated to appropriate personnel;
10. Appropriate training is being done to enable conformance to the QMS; and
11. The MOC process is used to facilitate appropriate management of changes to the QMS.

9.2.3 Review and Audit Reports

The QMS shall require findings or results of audits and management reviews to be reported in an appropriate form and communicated to appropriate personnel. Requirements for document control and retention time are addressed in Section 5.3, above.

9.3 Addressing Findings and Recommended Actions

Documented procedures or processes shall be established and maintained as part of the QMS to address nonconformances in an appropriate manner. Organizations shall verify these procedures or processes address the following:

1. Identifying and investigating nonconformances;
2. Determining causes of nonconformances;
3. Determining which type(s) of action(s) shall be implemented – corrective or preventive;
4. Preventing recurrence of nonconformances;
5. Documenting preventive and corrective actions to be taken;
6. Implementing actions;
7. Promoting appropriate communication; and
8. Reviewing the effectiveness of actions following implementation.

Both corrective and preventive actions may be used, as appropriate.


9.4 Learning from Events

Learning from events is critical to the continual improvement of the QMS. Formal, consistent, standard processes, such as incident investigations, shall be used to verify that a continuous improvement loop is in place to learn from events. In addition to formal processes, informal opportunities, such as employee concerns and impromptu feedback, should be utilized in an appropriate manner to improve the QMS.

In all cases, when changes are made to the QMS, those changes shall be managed in accordance with the MOC requirements.

9.4.1 Reactive Learnings

The QMS shall include a process for evaluating incidents and events related to quality in a manner that will promote determination of the root cause of the event, incorporation of the findings into the QMS, and communication of important information to employees to maximize the likelihood that quality issues are not repeated.



If the root cause of a failure of a pipeline in operation is determined to be related to a construction quality issue, actions shall be taken to determine if a similar situation could occur given the existing QMS and its associated processes and procedures. Efforts shall be taken to improve the QMS, as well as related procedures and processes.

9.4.2 Proactive Learnings

Proactive activities, such as near miss investigations, utilize information to predict possible quality problems and correct them in a proactive manner. Proactive activities can be utilized to identify potential quality concerns before an event occurs.

9.4.3 Informal Opportunities for Learning

Informal activities should also be considered as a means for capturing improvements to the QMS. Such activities may include, but are not limited to:

- Employee and contractor concerns and suggestions;
- Experiences with disgruntled personnel, personnel with ineffective training, or intentional negligence;
- On-the-job observations, e.g., inaccurate procedures;
- QA/QC observations; and
- Potential improvements identified by employees or contractors through the regular use of the QMS and related procedures or documents.


9.5 Management of Change

The MOC process shall be utilized when making changes to the QMS as a result of any continual improvement or other activity. Changes shall be communicated appropriately to personnel who could potentially be affected by the change, and any necessary training shall be conducted.

See Section 5.4 above for details regarding the requirements for MOC.

9.6 Monitoring and Measurement

Appropriate performance metrics shall be in place to provide information that will help the organization improve the QMS and communicate pertinent information. A combination of leading and lagging metrics should be considered in an effort to provide the most effective improvement.



APPENDIX B

QUALITY MANAGEMENT SYSTEM (QMS) FRAMEWORK AND GUIDANCE

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1.0 INTRODUCTION

This document is a framework for a quality management system (QMS) for onshore pipeline construction projects. The QMS developed for onshore pipeline projects shall include and document the following, which are discussed in more details throughout this framework:

- Defined project quality objectives and personnel accountabilities;
- Processes to establish and maintain the appropriate project organizational structure;
- Processes to establish and maintain the appropriate competency of internal and contracted personnel;
- Processes to facilitate and verify quality throughout project design, contracting, procurement, manufacturing, fabrication, and construction;
- Processes to prevent, detect, mitigate, and eliminate near-misses and non-compliances with project procedures, specifications, regulations, and referenced standards, as well as verification and documentation of actions taken and the outcome;
- Assessment of the achievement of quality objectives throughout the construction project; and
- Methods to measure each process's effectiveness and enact continual improvement of the QMS.

The term "shall" indicates that a provision is mandatory, while the term "should" indicates that a provision is recommended. The company shall document the justification(s) for not following a recommended provision, as applicable.

Guidance

This framework can be utilized to develop a stand-alone QMS or to integrate quality management into a company's existing corporate management system. Additionally, some processes covered in this framework may already be implemented by a company, for example, management of change (MOC). Existing processes may be modified to address the quality concerns identified in this framework.

Justification for not following recommendations in the guidance material of this document is not necessary.

2.0 SCOPE

This framework is applicable to construction activities that can affect the quality of onshore gas and hazardous liquid transmission and distribution pipelines, including activities from material procurement and inspection through pre-commissioning. Pipeline design and commissioning are considered outside of the scope of this document. The framework shall be used to aid in the development of a company-specific QMS.

Guidance

This framework was not developed to include gathering pipelines; however, the principles included within the framework could be utilized to develop a QMS for gathering pipelines. Additionally, an operating company may choose to expand the scope of their individual QMS to cover design, commissioning, or other related tasks.

3.0 TERMS AND DEFINITIONS

The following terms and associated definitions are utilized throughout this framework document.

- a) Audit - a systematic, independent, and documented process for obtaining records or information and evaluating it objectively to determine the extent to which a set of policies, procedures, or requirements are fulfilled.
- b) Complete - when describing records, able to be confirmed as finalized as evidenced by a signature, date, or other appropriate marking.

- c) Corrective Measure – an action taken to respond to the quality situation thereby limiting adverse consequences (i.e., actions taken to rectify an existing situation).
- d) Inspection – an evaluation for conformity by observation and judgment accompanied, as appropriate, by testing and/or measurement.
- e) Monitoring – a continuous, albeit not necessarily constant and complete, observation of parameters affecting the quality of a process. The intent of monitoring is to allow personnel, such as an inspector, to observe the activity or request performance data as needed.
- f) Preventive Measure – an action taken to eliminate the causes of a potential quality issue in order to prevent occurrence (i.e., actions taken to prevent a situation from occurring. For instance, actions arising from a risk assessment or near miss).
- g) Project – a temporary endeavor undertaken to create a unique product, service, or result.¹
- h) Qualification – an activity or process carried out to demonstrate that a procedure, material, or technology is able to fulfil specified requirements. This is typically associated with an extended volume and modified scope of testing, as compared to normal production.
- i) Quality Assurance (QA) – proactive, process-oriented activities, independent of production, with the goal of preventing quality issues. Examples of QA activities include audits, checklists, and the development of standards.
- j) Quality Control (QC) – reactive, product-oriented activities with the goal of identifying quality issues before work is finalized. Examples of QC activities include inspection and testing.
- k) Quality Event – any potential or actual issue that may affect quality. The following definitions further describe specific quality events.
 - i. Near Miss – an event where quality was not affected, but had the potential to be affected. An example of a near miss is an inspector stopping an improper backfilling task as the machinery operator is about to commence. A near miss is often a situation or event that may not be known to others outside the activity or project. If not attended to at an early stage, near misses can develop into actual quality issues.
 - ii. Nonconformance – failure to follow a standard, specification, procedure, plan, etc., or non-fulfillment of a requirement contained in such document. An example of a nonconformance is field-bending a pipe to the wrong angle but recognizing the error prior to use of the bend during construction. Company representatives and contractors alike can commit nonconformances.
 - iii. External Complaint – a statement of dissatisfaction by an external customer (verbally or in writing) that the work or services provided do not meet the stated or implied needs or expectations of the customer.
 - iv. Audit Finding – a nonconformance, observation, or improvement opportunity identified during either internal audits or external audits conducted by third parties or auditors.
 - v. Incident – an undesired event that adversely affects quality. These could include damages or failures, failures to meet quality standards in the absence of damage, complaints that were caused by conformance to substandard procedures or specifications, or failures to comply with appropriate procedures or specifications. An example of an incident is lowering the pipeline into a rocky ditch and creating an unacceptable dent in the pipe.

¹ From PMI's "A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Fourth Edition.

- vi. Improvement Proposal – an action identified by the operating company or suggested by an employee or contractor that may lead to an improvement in the company's quality standards, quality performance, or effectiveness of the QMS.
- l) Quality Management System (QMS) – A systematic approach designed to manage a company's objectives, policies, procedures, and processes with regards to quality. Quality is managed using four main activities: quality planning, quality assurance (QA), quality control (QC), and quality improvement.
- m) Quality Plan - a document specifying which procedures and associated resources shall be applied by whom and when to a specific process. For pipeline construction, a quality plan shall be developed for each construction task (stringing, welding, backfilling, etc.)
- n) Risk - the probability of an event and its associated consequence.
- o) Supervise - to observe and direct the execution of a process, activity, or task.
- p) Traceable – when describing records, able to be clearly linked to original information regarding a pipeline segment or facility.
- q) Verifiable – when describing records, able to confirm information by other complementary, but separate, documentation.
- r) Verification - an examination to confirm and communicate (or record) that an activity, product, service, or document is in accordance with specified requirements.
- s) Witnessing - the presence at and observation of a defined and specified event or test. Work shall not proceed until the inspector is available to witness the event. This is equivalent to a "hold point" in the production. The inspector may, however, in advance inform in writing or through a formal minute of meeting that his/her presence is not required.

4.0 ABBREVIATIONS

ACCP	ASNT Central Certification Program
ACVG	Alternating current voltage gradient
API	American Petroleum Institute
ARO	Abrasion resistant overlay
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	ASTM International, formerly American Society for Testing and Materials
BPVC	Boiler and Pressure Vessel Code
CE	Carbon equivalent
CFR	Code of Federal Regulations
CP	Cathodic protection
CSA	Canadian Standards Association
CTOD	Crack tip opening displacement

CVN	Charpy V-notch
DCVG	Direct current voltage gradient
DNV	Det Norske Veritas, currently DNV GL
DOC	Depth of cover
EN	Europäische Norm (European Standard)
EPC	Engineering, procurement, and construction
FBE	Fusion bonded epoxy
FCAW	Flux cored arc welding
FFS	Fitness for service
GMAW	Gas metal arc welding
GPS	Global positioning system
HAZ	Heat affected zone
HCA	High consequence area
HDD	Horizontal directional drill
HSE	Health, safety, and environment
ILI	In-line inspection
ISO	International Organization for Standardization
ITP	Inspection and test plan
MAOP	Maximum allowable operating pressure
MOC	Management of change
MOP	Maximum operating pressure
MPS	Manufacturer procedure specification
MTR	Material test record (or material test report)
NACE	NACE International, formerly National Association of Corrosion Engineers
NCR	Nonconformance report
NDT	Non-destructive testing
NS	Norsk Standard
OD	Outside diameter
OQ	Operator qualification, or "Op Qual"
PDCA	Plan-do-check-act
PEP	Project execution plan
PHMSA	Pipeline and Hazardous Materials Safety Administration
PMI	Positive material identification

PPE	Personal protective equipment
PPI	Plastics Pipe Institute
PQP	Project quality plan
PRCI	Pipeline Research Council International
QA	Quality assurance
QC	Quality control
QMS	Quality management system
RFI	Request for information
RFP	Request for proposal
ROW	Right of way
RP	Recommended practice
SMAW	Shielded metal arc welding
SME	Subject matter expert
SMYS	Specified minimum yield strength
SSPC	The Society for Protective Coatings, formerly Steel Structures Painting Council
TOR	Terms of reference
TR	Technical report
UT	Ultrasonic testing
UV	Ultra-violet
WPS	Welding procedure specification
WT	Wall thickness

5.0 GENERAL

5.1 Quality Management System

A QMS shall be developed, implemented, maintained, and continually improved by the operating company in accordance with this framework document. An operating company's QMS shall include requirements for suppliers, contractors, and subcontractors to verify that quality requirements are met, as applicable.

5.2 Approach

The development, implementation, maintenance, and continual improvement of a QMS shall be achieved using a "process approach" by performing and documenting the following:

- Identification of the project processes and construction activities that require management;
- Identification of the interactions between various project processes and construction activities;
- Determination of the criteria and methods required for the effective execution and monitoring of these processes;
- Determination of the resources required to execute and monitor the QMS processes, as well as the assurance of the availability of necessary resources;

- e) Measurement, monitoring, inspection, and analysis of these processes and construction activities; and
- f) Implementation of the activities required to achieve quality results and continual improvement.

Additional information regarding QMS project implementation is presented in Section 8.0, below.

Guidance

As defined in Section 3.0, a project is defined as "a temporary endeavor undertaken to create a unique product, service, or result." For routine construction activities with limited work scope, such as the installation of a new hot tap connection, the operating company may choose to define multiple occurrences of an activity as a single "project." This would enhance scalability of the QMS and allow development of one set of QMS-related guidelines and procedures that would be applicable to multiple occurrences of the routine activity.

The operating company is responsible for determining when the details of activities are sufficiently different from other occurrences of the activity that a review and modification of the procedures, resources, personnel qualifications, inspections, etc. may be warranted.

5.3 Documents and Records

Guidance

For the purpose of this framework, a "document" contains plans or instructions for what actions will be performed. Documents can be continually improved and examples include the QMS manual, project specifications, procedures, and inspection forms. Alternately, a "record" shows proof of compliance with a document's requirements at a single point in time. Examples of records include meeting minutes, training records, and inspection reports.

One of the objectives of the document and record management system should be to produce records that are 'traceable, verifiable, and complete'.

5.3.1 General

The operating company shall assemble, manage, and maintain the following major types of documentation and records:

1. Documented requirements for the ways in which the operating company expects each element of the management system to be met. These requirements may be included in a document such as a QMS manual or written management system and should include but may not be limited to the following:
 - a. QMS policy and objectives;
 - b. Roles and responsibilities;
 - c. Requirements of each QMS element outlined in this framework; and
 - d. Any additional company-specific requirements, as applicable.
2. Supporting documentation and records to demonstrate conformance with the QMS requirements, including:
 - a. Procedures;
 - b. Planning, operation, and process control documents; and
 - c. Records.

The operating company should perform a needs analysis to determine which records and documents shall be retained, both for regulatory or legislative reasons, as well as to conform to company requirements. In addition to maintaining records and documents, the operating company shall store the information in an

appropriate manner, i.e., in a format that allows usability, reliability, authenticity, accountability, and preservation, thereby confirming they are 'traceable, verifiable, and complete.'

Guidance

Suggestions for the minimum required documentation and records are contained in Table 5.3.1-1 for a selection of the QMS and project-level processes. This table is not all-inclusive.

Table 5.3.1-1 Minimum Considerations for Documentation and Records Requirements

Element	Requirement
QMS Scope	<ul style="list-style-type: none">• Document the applicability of the Quality Management System as it pertains to the organization and its assets. Include the types of construction projects that do fall under this scope as well as any exclusions that may not.• Identify links to other programs that connect to or incorporate pieces of the QMS.
QMS Policy and Objectives	<ul style="list-style-type: none">• Document the organization's policy on managing quality during construction projects and the objectives the organization strives to achieve through the QMS.
QMS Records and Documents	<ul style="list-style-type: none">• Document the methods used for managing QMS records and documents.• Maintain an index of the records and documents that contain information that is relevant to, or used in conjunction with, the QMS.• Identify the person or role responsible for maintaining and approving documents and records related to the QMS and its associated activities.• Define minimum requirements for records to be traceable, verifiable, and complete.<ul style="list-style-type: none">◦ To be traceable, the records should allow line pipe and components to be clearly linked to specific orders and original documentation about a component, segment, or facility.◦ To be verifiable, separate, independent, or complementary records may be needed.◦ To be complete, the records need to meet PHMSA requirements for completeness, including dates and approval signatures.• Establish and document the review process to confirm that the documentation/records meet those requirements and are complete and reliable.

Table 5.3.1-1 Minimum Considerations for Documentation and Records Requirements (continued)

Element	Requirement
Management of Change	<ul style="list-style-type: none"> • Develop and implement a management of change process for changes that have the potential to affect quality of construction projects or the ability of the project team, construction team, or contractors to maintain quality. • Verify the MOC process procedures are in place to address and document quality-related changes. • Define and implement performance indicators for management of change. • Document risks associated with changes that are managed through the MOC process and the ways in which they could potentially affect the company.
Management Responsibility	<ul style="list-style-type: none"> • Document management's responsibilities and accountabilities related to maintaining and supporting the QMS as well as activities associated with verifying construction quality.
Contractor and Supplier Responsibility	<ul style="list-style-type: none"> • Document the responsibilities of contractors and suppliers as they relate to producing and providing services, products, and equipment. • Define the organization's expectations of contractors and suppliers as they relate to quality of construction activities. Verify a process is in place to communicate the expectations in a written agreement.
Competency and Training	<ul style="list-style-type: none"> • Document competency and training requirements for company personnel, contractors, and consultants to provide them the appropriate knowledge and skills for performing the activities in a manner that promotes and verifies quality during construction projects. • Maintain training records for QMS awareness and construction activities that have the potential to impact quality.
QMS Project Implementation	<u>Project Quality Risk Management:</u> <ul style="list-style-type: none"> • Develop a formal written process to identify and address quality risks associated with projects. This should include documenting the ways in which the risks are being controlled and managed. Examples of quality risks and related mitigation measures are contained in Section 8.2, below. • Document the type of risk assessment conducted.
	<u>Pre-Construction Considerations:</u> <ul style="list-style-type: none"> • Verify engineering and design standards clearly state the required materials and design required for specific application on construction projects. Document the assumptions and design conditions so that the management of change process can trigger a review of selected designs and materials in response to changes in design conditions.

Table 5.3.1-1 Minimum Considerations for Documentation and Records Requirements (continued)

Element	Requirement
QMS Project Implementation (continued)	<p><u>Management Review:</u></p> <ul style="list-style-type: none"> • Establish and document the process to be used for management review of the QMS and its elements. Include the required time period for review. • Establish and maintain procedures for defining responsibility and authority for handling and investigating nonconformances, taking action, and initiating, completing, and documenting corrective and preventive actions.
Continual Improvement	<p><u>QMS Audits:</u></p> <ul style="list-style-type: none"> • Document the requirements for how, where, and how long QMS audit reports should be kept. • Maintain QMS audit reports in a manner that allows for efficient retrieval and access by authorized personnel. • Verify there is a way to demonstrate that the results of audits are communicated to, and agreed with, those who were audited, communicated to management, included in the management review process, and followed-up through to completion.
	<p><u>Findings and Recommendations:</u></p> <ul style="list-style-type: none"> • Document the method(s) for tracking findings and recommendations, their associated corrective actions, and the process for closure of the items. • Maintain records of recommendations and closure of recommendations • Document the process for consulting with and informing appropriate personnel about quality issues and findings from audits and management reviews.
	<p><u>Learning from Events:</u></p> <ul style="list-style-type: none"> • Establish procedures for investigating and reporting quality incidents as well as near misses. • Document the feedback loops and methods for communication to potentially affected company and contractor personnel. • Document the requirements for what should be included in incident and near miss reports, such as, but not limited to, the following: <ul style="list-style-type: none"> ◦ A description of what occurred ◦ Initial actions taken ◦ An evaluation of potential severity and probable frequency of recurrence ◦ Identification of root cause(s) ◦ Need to notify regulatory authorities • Recommended corrective and/or preventive actions to prevent recurrence
	<p><u>Monitoring and Measurement:</u></p> <ul style="list-style-type: none"> • Define, document, and track performance indicators for the written QMS and associated critical activities.

5.3.2 Control of QMS Documents

The operating company shall establish procedures for the control and dissemination of QMS documents, including:

- Identification of documents that are required for the effective implementation of the QMS;
- Identification and review of documents that require access control and/or distribution control;
- Approval of documents, including assurances of legibility and accessibility;
- Identification of the current revision of each document, including procedures for removal of obsolete/invalid documents from circulation and use; and
- Maintenance of documents, including back-up and archival of critical or obsolete documents.

Guidance

The operating company may already have a document control process/system in place for existing company document or records which can be used to manage the QMS documents.

5.3.3 Control of Records

The operating company shall establish procedures for the control of records that demonstrate compliance with and the effectiveness of their QMS. Such records are generated as part of the QMS process and shall be identified, organized, and retained. It is recommended that such records be maintained for the life of the pipeline or project.

Guidance

Examples of applicable records include:

- *Management review records;*
- *Contracts and contract review records;*
- *Correspondence and meeting minutes;*
- *Design review, verification, and validation records;*
- *Management of change (MOC) records;*
- *Descriptions of approved suppliers and contractors;*
- *Engineering/technical inquiries and associated responses;*
- *Traceability records, including equipment tag numbers and lists;*
- *Qualified processes, equipment, and personnel;*
- *Training records;*
- *Inspection and test records;*
- *As-built information;*
- *Nonconformance reports and records of subsequent actions;*
- *Internal and external audit reports;*
- *Records for monitoring and measurement activities; and*
- *Standard formats and templates.*

5.4 Management of Change

The QMS shall include a Management of Change (MOC) process to control, evaluate, verify, and validate technical and administrative (non-technical) changes to the design, contracting, procurement, manufacturing, fabrication, and construction of new pipelines, as well as changes to the QMS itself. Each MOC request must be approved prior to implementation. The review of such changes shall include evaluation of the effect each change or suite of changes can potentially have on construction quality.

Guidance

The MOC process should identify the types of changes to be managed, provide a means of verifying the process is consistently utilized, and include metrics to determine if changes are being evaluated as intended by the QMS. Each change should be evaluated based on the significance of the change, the need, technical

basis, and expert evaluation of the risk associated with the change. Utilizing this information, authorization to proceed with the change should be determined.

It is critical that the MOC is effectively communicated to all impacted parties to facilitate effectiveness. Additionally, records of MOC reviews and any necessary actions should be maintained as part of the MOC process. Any action items should be addressed as outlined in Section 9.0, below, and tracked to closure.

Management of technical changes associated with pipeline construction projects and engineering design should be conducted to verify engineering regulations, codes, and standards are being met and to take into account ways in which the change can affect the quality of construction. Appropriate subject matter experts should evaluate whether the risks associated with the change have been identified and understood by parties who can affect the risk or be affected by it and whether the risks have been mitigated or addressed appropriately.

5.4.1 Managing Administrative Changes

Changes to the written QMS document, as well as other associated administrative processes, procedures, and requirements shall be managed to determine the effects they may have on quality of new pipeline construction.

When managing changes to the written QMS, the requirements for Continual Improvement, discussed in Section 9.0, below, shall be followed as outlined in the QMS document. In addition, the effect the change may have on the organization's risk profile, risk tolerance, quality philosophy, and other corporate standards shall be evaluated with the change.

Guidance

The organization should verify the MOC process manages changes that can affect the following, at a minimum:

- 1. Approved supplier, contractor, and vendor lists;*
- 2. Supplier, contractor, and vendor agreements and contract terms;*
- 3. Procurement practices and requirements;*
- 4. Contractor management practices and contractor oversight requirements;*
- 5. Engineering standards;*
- 6. Material and design specifications;*
- 7. Supplier/contractor requirements;*
- 8. Construction and installation practices and procedures;*
- 9. Safe work practices;*
- 10. Spare parts requirements;*
- 11. Modifications to operating philosophy or procedures; and*
- 12. Changes in the designation of key personnel responsible for specific work scope items, decision making, or communication requirements.*

5.4.2 Managing Temporary Changes and Exceptions

The QMS shall include requirements for managing temporary changes to construction practices, temporary exceptions to the QMS requirements, and exceptions to specifications. Although temporary in nature, these changes shall be evaluated to determine if they present a risk to the quality of the pipeline's overall construction, integrity, operation, personnel safety, or environmental safety.

Guidance

The following listing provides examples of temporary changes; however, it is not intended to be a complete listing:

- 1. A temporary change to a backfill procedure, due to extreme weather conditions;*
- 2. An exception to a material specification resulting from a shortage of the material; or*
- 3. A local exception to the procurement requirements resulting from limited choices in vendors.*

5.4.3 Learning from Events

Following continuous improvement activities from quality events, such as external complaints, incident investigations, near misses, nonconformances, audits, improvement proposals, or planned assessments, the organization may suggest changes to improve the QMS or quality management processes for pipeline construction projects. Prior to the implementation of suggested changes on currently on-going projects, the MOC process, as described in Section 5.4, shall be utilized to minimize the likelihood that the change will adversely affect the quality of the pipeline construction project.

Guidance

Suggested changes may come from either internal or external quality events. For example, an operating company may choose to improve their QMS following a public quality incident experienced by another operating company.

6.0 MANAGEMENT RESPONSIBILITY

6.1 Owner Company Responsibility

The owner company, as the entity who is funding the construction and may operate the pipeline, has the ultimate responsibility for the quality of the finished assets including:

- Conformance to regulations;
- Conformance to standards of the industry;
- Conformance to company specifications; and
- The ability of the pipeline and associated facilities to perform the intended function on a sustained basis in a safe and environmentally sound manner.

In addition to legal requirements, owner companies require public acceptance and trust (sometimes referred to as "privilege to operate") in order to operate effectively due to the possible severe consequences of failure. In order to define and communicate the standard of care to be achieved, companies have the responsibility to set guiding principles, typically in the form of publicly expressed values statements.

When utilizing contractor services, the owner company shall verify the QMS and associated project specifications/requirements are followed by the contractor.

Guidance

The quality of the assets to be constructed should be consistent with the espoused principles. Therefore the owner company has the responsibility to put into place a QMS with sufficient definition to design, procure, install, and place into operation a pipeline asset that meets the standard of care. The company must verify:

- *Contractors have the ability to construct the pipeline safely within their scope;*
- *Suppliers provide materials and equipment that meet requirements;*
- *Fabrication and construction meets or exceeds commonly accepted industry standards as supplemented by company or project specifications;*
- *Control of the project is maintained through competent project management; and*
- *The installed asset meets the standards and specifications through shop and field inspection and testing.*

6.1.1 Management Commitment

Management shall commit to developing, implementing, and continually improving the effectiveness of the QMS by:

- Establishing the quality policy and its objectives;
- Communicating to the entire organization the importance of meeting all statutory, regulatory, and company requirements;
- Maintaining documented approval and support of the QMS by company management;
- Conducting management reviews;
- Confirming the availability of resources;
- Preventing conflicts between project cost/schedule and quality; and
- Identifying and documenting company requirements in applicable orders, contracts, and specifications.

Guidance

Implementing and utilizing a fully-functional QMS will require additional up-front costs and staffing for onshore pipeline construction projects. However, these additional costs will promote a higher quality pipeline and may reduce operational and repair costs over the life of the pipeline. Management should be committed to providing the required resources.

Additionally, management should work to prevent conflicts between project cost/schedule and quality. Quality should be considered equal in importance to safety; work stoppages or additional costs to achieve quality should be considered continual improvement opportunities.

6.1.2 Policy

The Company shall establish a Quality Policy. The Quality Policy describes the company's intentions with regards to managing quality utilizing a QMS; it shall:

- Be appropriate for the purpose of the organization and aligned with the company values;
- Provide for a framework for establishing and reviewing quality objectives;
- Be managed through a management review process;
- Be communicated and understood within the organization;
- Be reviewed on a regular basis for continuing suitability; and
- Have documented approval by company management

6.1.3 Communication

Communication processes must be established which facilitate awareness, understanding, and acceptance of the QMS and associated processes and procedures throughout the organization, as well as by contractors and other external stakeholders. Critical communications that require action shall be tracked through completion.

Guidance

Channels should exist to allow communication to flow from management to project/field personnel and vice versa.

6.1.3.1 Internal Communication

Internal communication processes link management, employees, and other internal stakeholders. The attainment of the quality goals depends on successful communication. The communication process shall allow for employees to give feedback and provide possible solutions to issues.

Key communication processes include:

- Establishment, communication of, and adherence to best practice;

- Learning opportunities from ongoing activities, near-misses, and incidents;
- Effective MOC communications; and
- Clear communication of roles, authorities, and responsibilities.

6.1.3.2 External Communication

The external communication process shall include:

- Sharing of company requirements and expectations;
- Sharing of best practice;
- Learning opportunities from ongoing activities, near-misses, and incidents;
- Key contacts and elevation plans for technical and non-technical inquiries; and
- Approval processes for subcontracting or other contractual changes.

Guidance

Achieving buy-in of the QMS by external stakeholders is crucial to the overall quality of the project. This is why clear communication of the QMS, expectations of the contractor, and responsibilities of the contractor within the QMS framework are essential activities during the contracting phase of each project.

6.1.4 Organization

6.1.4.1 Responsibilities and Authorities

The responsibilities and authority of each role in the organization with respect to the QMS or construction project shall be defined and documented. The responsibilities and authorities for each role shall be communicated throughout the organization to promote awareness.

Guidance

In addition to the defining of responsibility and authorities, minimum training and competency requirements should be established for all roles and should include criteria that must be met in order to hold a given role. Competency and training requirements should include assessments that verify that individuals have the knowledge and experience needed to perform the required tasks and make informed decisions. Additional information on training and competency can be found in Section 7.2.1, below.

6.1.4.2 QMS Management Representatives

A management representative shall be appointed within each appropriate organizational unit to:

- Promote the establishment, implementation, and maintenance of processes needed for the QMS;
- Apply lessons learned from previous projects;
- Communicate to management regarding the performance of the QMS and need for improvement with regard to their organizational unit; and
- Facilitate the promotion of awareness within the organization as a whole.

Guidance

Organizational units will vary among individual companies but may include:

- *Project Management;*
- *Business Development;*
- *Public and Government Affairs;*
- *Right Of Way;*
- *Engineering;*
- *Procurement;*
- *Construction;*
- *Safety;*
- *Operations - Start-Up/Commissioning; and*
- *Compliance.*

6.1.4.3 Avoiding Conflict of Interest

Management shall have procedures and policies in place to both recognize the potential for conflict of interest and to minimize the likelihood that quality objectives are affected by conflict of interest.

6.1.5 Management Review of QMS

6.1.5.1 General

A management review shall be defined and carried out at the frequency necessary to promote the continuing effectiveness of the QMS, examine current issues, and assess opportunities for improvement. Additionally, continual improvement activities, conducted by individual or cross-functional groups, shall be reviewed. Management reviews shall be documented.

6.1.5.2 Review Input

The management review input shall include information relative to the performance of the QMS and detection, mitigation, and resolution of quality issues. In addition, the review shall consider the potential effect of external influences on quality requirements.

Guidance

The management review input information should include but may not be limited to the following:

- *Nonconformances;*
- *Status of preventive and corrective actions;*
- *Follow-up actions from previous management reviews;*
- *Changes in the organization's operational environment that could affect the QMS including the requirements for additional or revised resources;*
- *Audit results;*
- *Overall performance of the QMS and opportunities for improvement; and*
- *Changes in applicable regulatory requirements or applicable industry consensus standards.*

6.1.5.3 Review Output

The output from the management review shall include any actions related to:

- Verification and documentation of corrective and preventative measures taken or planned;
- Reallocation or supplementing of resources;
- Redefinition of responsibilities or changing organizational details;
- Changes to procedures and/or documentation practices to meet changes in company specifications and/or regulatory requirements;
- Changes to policy; and
- Setting new quality objectives and initiating actions to improve the QMS, processes, and products.

Guidance

The format of the review output should be determined by the company. Additionally, a process should be implemented to track the completion of any required actions.

6.2 Contractor and Supplier Responsibility

When required by the operating company, contractors and suppliers to the operating company shall have their own QMS which is aligned with that of the operating company's QMS.

Additionally, the contractors and suppliers shall be responsible for the quality of their supplied products or services, including:

- Conformance to regulations;
- Conformance to standards of the industry; and
- Conformance to applicable specifications and company requirements.

Guidance

It is recommended, at minimum, that the operating company require QMS alignment from suppliers of pressure-carrying pipe and components, as well as the construction contractor(s).

The quality of the design, procurement, manufacturing, fabrication, and construction of pipeline equipment has substantial impact on the safe operation of the pipeline asset. It is essential that contractors, suppliers, and the operating company achieve alignment on quality. Quality should be considered equal in importance to safety with any issues that arise addressed with full transparency.

The responsibilities of contractors and suppliers include:

- Establishing common objectives and a cross-company project organization that communicates and works together as one;*
- Focusing their organization on the customer's objectives and overall satisfaction;*
- Accurately determining and understanding customer requirements to achieve high customer satisfaction and verify that the requirements are met;*
- Committing to prevent conflicts between project cost, schedule, and quality; and*
- Producing a quality product that meets specifications.*

6.2.1 Contractor and Supplier Management Commitment

Contractor and supplier management shall commit to implementing and continually improving a QMS which supports and is aligned with the client's QMS by:

- Verifying that customer requirements are identified and are well understood by careful review of the order, contract, and specifications;
- Establishing the quality policy and its objectives;
- Communicating to the entire organization, including any subcontractors, the importance of meeting client requirements as well as all statutory, regulatory, and company requirements;
- Preventing conflicts between project cost/schedule and quality;
- Conducting and documenting formal management reviews to verify the policy's continuing suitability and effectiveness and responses to identified deficiencies or nonconformances; and
- Verifying that resources required to satisfy the quality requirements of the client procedures and specifications are available and provided.

6.2.2 Contractor and Supplier Policy

The Quality Policy shall:

- Be appropriate to purpose for the organization and aligned with the company and client organization values;
- Be managed through a process including management reviews on a regular basis to verify its continual suitability;
- Set the requirements for the QMS and continuously improve its effectiveness through monitoring and measurement;
- Provide for a framework for establishing and reviewing quality objectives;
- Be communicated and understood within the organization and by client organizations; and
- Be capable of addressing the quality requirements of various pipeline operator organizations recognizing that there could be significant differences among the policies and specifications for each operating company.

Guidance

Contractors and suppliers support the quality programs of pipeline operating companies by:

- *Promoting conformance to project procedures and specifications, particularly with regard to attributes or characteristics that cannot be effectively inspected or audited after delivery;*
- *Resolving nonconformance reports, and especially communicating root cause analysis results so that pipeline operating companies can modify specification, procedures, procurement practices, or quality programs in future projects to prevent reoccurrence; and*
- *Partnering with the pipeline operator to identify opportunities for cost effective improvements in procedures or specifications that will have a positive influence on quality.*

6.2.3 Communications

The communication process for contractors and suppliers shall promote effective communication with both the designated representative(s) of the pipeline operator and within the contractor or supplier organization to facilitate timely communication, understanding, and performance of the project requirements.

Guidance

One topic of critical interest to pipeline operating companies is the receipt of timely updates regarding an identified, unexpected inability to meet previously agreed upon procedures, specifications, or schedules. Secondly, if nonconformances are identified in deliverables, follow-up communications with the pipeline operating company should address the root cause and mitigative/preventative measure(s) to reduce the likelihood of reoccurrence.

Management communications to the organization include:

- *The quality policy and objectives;*
- *Customer and regulatory requirements;*
- *Product and process specifications;*
- *Verification and validation requirements; and*
- *Instructions on how to implement and use the QMS.*

Organization communications to the management include:

- *Information and data regarding quality performance;*
- *The effectiveness of the QMS;*
- *Customer satisfaction; and*
- *Opportunities for improvement.*

6.2.4 Contractor and Supplier Organization

6.2.4.1 Responsibilities and Authorities

Contractors and suppliers should share a complete description of their relevant organizational structure with the pipeline operating company. All roles, together with personnel who hold the roles, with the responsibility to manage, perform or verify work affecting quality should be specifically identified.

Guidance

Contractors and suppliers should have a designated staff member that serves as the primary point of contact with the pipeline operator. The level of authority assigned to key contacts should be clearly identified. In addition, the contractor or supplier should identify or describe the process by which issues that exceed the key contact's level of authority will be resolved. An alternative or secondary key contact should be identified for use when the primary key contact is unavailable.

6.2.4.2 Management Representative

The contractor or supplier should have a management representative, a designee in a senior position whose duties include the primary responsibility for verifying that the quality-related aspects of the task or project are met.

Guidance

The Management representative may or may not be the primary point of contact with the pipeline operator, as discussed in the guidance associated with Section 6.2.4.1.

6.2.4.3 Avoiding Conflict of Interest

Supplier and contractor management shall have procedures and policies in place to both recognize the potential for conflict of interest and to minimize the likelihood that quality objectives are affected by conflict of interest.

Guidance

Conflicts of interest can take many forms. From the standpoint of quality management, conflict of interest is most likely to occur when the contractor's or supplier's business pressures of meeting cost goals conflict with the pipeline operator's objective of receiving deliverables of the best possible quality.

One effective method of minimizing potential problems associated with managing the competing goals of maximizing profit and providing high quality deliverables is to have QA/QC and inspection staff report to management that is not directly responsible for deliverable production.

Another potential source of conflict of interest occurs when employees are able to personally profit from decisions they make in their business relationships with their suppliers and service providers. The personal profit can come at the expense of the end user when the actions result in procurement of substandard raw materials and eventual production of substandard deliverables, or delivery of components or services that meet project requirements but at inflated prices.

The likelihood of unethical behavior is reduced by strict adherence to review and approval protocols and periodic internal audits of procurement, production, and QA/QC practices. Internal audits should be performed by personnel who are not directly involved with the functions being audited.

6.2.5 Contractor and Supplier Management Review of QMS

6.2.5.1 General

A management review shall be defined and carried out at the frequency necessary to verify the continuing effectiveness of the system, examine current issues, and assess opportunities for improvement. Additionally, continual improvement activities, conducted by individual or cross-functional groups, shall be reviewed. Management reviews shall be documented.

Guidance

The contractor and supplier management review is performed on their own, internal QMS. This review verifies the contractor/supplier QMS is properly aligned with the owner company QMS. Any deficiencies noted should be appropriately addressed.

6.2.5.2 Review Input

Management review shall consider inputs relevant to the organization's conformance to the QMS, external changes that could influence the QMS or quality requirements, and any identified deficiencies in the QMS.

Guidance

The management review of input information should include the following:

- *Nonconformances reported by internal staff. These reflect failure of the production process to produce deliverables of acceptable quality;*
- *Nonconformances reported by the pipeline operator. These reflect failure of the production process to produce deliverables of acceptable quality and failure of the QA/QC/inspection process to detect the nonconformance, or a difference in understanding of the procedure or specification requirements by the pipeline operator compared to the contractor or supplier;*
- *Results of audits and status of preventive and corrective actions;*
- *Status of actions from earlier management reviews;*
- *Customer feedback and complaints;*
- *Changes in the organization's operational environment that could affect the QMS including the requirements for additional or revised resources;*
- *Changes in specifications or procedures referenced by pipeline operators in RFPs or purchase orders that impact quality requirements;*
- *Overall performance of the QMS and opportunities for improvement;*
- *Performance data;*
- *Status of quality objectives; and*
- *Changes in applicable regulatory requirements.*

6.2.5.3 Review Output

The output from the management review shall include any actions related to:

- Verification of corrective and preventative measures taken or planned to address nonconformances reported by internal staff;
- Corrective and preventative measures taken or planned to address nonconformances reported by the pipeline operator;
- Reallocation or supplementing of resources;
- Redefinition of responsibilities or changing organizational details;
- Changes to procedures and/or documentation practices to meet changes in client specifications and/or regulatory requirements;
- Changes to policy; and
- Setting new quality objectives and initiating actions to improve the QMS, processes, and products.

7.0 RESOURCE MANAGEMENT

7.1 Provision of Resources

The operating company shall determine the resources required to develop, document, implement, manage, supervise the application of, and continually improve the QMS.

Guidance

Those resource requirements may be met by providing a combination of company staff and contracted, supplemental staffing.

7.2 Human Resources

7.2.1 Training and Competency

The operating company is responsible for developing, documenting, implementing, managing, supervising, and continuously improving a program that trains personnel to meet the requirements of the QMS and other applicable company standards, specifications, and regulations in a safe and environmentally responsible manner. Applicable training and competency requirements shall be applied to both operating company personnel and contractor/supplier personnel responsible for the QMS system and for all stages of pipeline construction projects, including design, planning, materials procurement, construction, testing, and inspection. The training and results of competency testing shall be documented and retained for at least as long as the life of the systems on which the employee has worked or for the duration of the contract or employment period, whichever is longer.

Guidance

Competency may be measured by company-administered testing and/or job demonstration, external certification programs, or a combination of both. Consideration should be given to periodic retesting or re-certification.

Training and competency verification programs should be defined for the personnel performing work, which may be employed by the operating company, contractor, or supplier, and should include:

- *Determining the competency needs for critical job activities;*
- *Determining the best mechanism for developing the competency, for example a combination of classroom training, practice on mock-ups, and specified amount of on-the-job training under the supervision of a qualified individual;*
- *Determining the most effective method of evaluating the competency and an acceptable assessment metric;*
- *Determining a re-training and evaluation protocol for those who don't demonstrate adequate competence or who later demonstrate unacceptable work quality after having been judged to be competent;*
- *Setting appropriate levels of differentiation between training and evaluation requirements for experienced employees and contractors compared to the needs of new employees with developing skills or employees in new positions;*
- *Identifying mechanisms for supplemental or revised training and evaluation to address changes in existing procedures or addition of new procedures;*
- *Measuring the effectiveness of the training by comparing work performance to competency evaluation results;*
- *Determining the need for periodic evaluation or auditing of work performance; and*
- *Setting training, evaluation, and auditing result documentation formats and requirements.*

Competence evaluations can take many forms; examples include written examinations, oral examinations, demonstrations of competence, previous job experience, on the job evaluations by an "expert" in the task, the results of previous evaluations, or a combination thereof.

7.2.2 Contractor Services

The operating company shall develop, document, apply, and refine processes at specified intervals to verify that contractor services meet or exceed the quality standards of the QMS. If necessary, the specified intervals may be reduced to address unexpected deficiencies or nonconformances. Contractor selection processes shall include, but not be limited to, comparison between the demonstrated capabilities (rather than claimed capabilities) of the contractor and the applicable requirements of the QMS. Furthermore, the

evaluation shall consider the contractor's demonstrated ability to meet the applicable quality standards while working in a safe and environmentally sound manner.

Guidance

The company should include reviewing the contractor's quality policies, related procedures, and demonstrated performance in like or similar projects in the contractor qualification and selection process. Review of documentation should be supplemented with observations of employee work performance and on-site audits, when warranted by the risk of failure to meet quality standards and other requirements of the project. Additionally, the contractor(s) and supplier(s) should be held responsible by the operating company for meeting or exceeding the quality standards as defined by the operating company.

The same considerations should be applied to the qualification of any subcontractors used by the contractor. The contractor shall be responsible for verifying the subcontractor meets the quality standards set forth in the owner company's QMS. The operating company shall designate the process by which subcontractors will be identified, reviewed, and approved, as applicable. Additionally, the contractor shall be responsible and accountable for any deficiencies in deliverables generated by the subcontractor regardless of the approved use of the subcontractor by the operating company.

The operating company shall define and document performance standards and communicate those to the contractor. The contractor and operating company shall jointly define a suitable method and frequency of audits and performance monitoring and the manner in which the contractor will support the monitoring and assessment of contractor performance.

Guidance

The operating company should determine how much control over the selection, qualification, and performance measurement of subcontractors is warranted by the subcontracted work scope and the associated risk. It is generally beneficial to address requirements for selection and preapproval of subcontractors, if applicable, in contracts between contractors and the operating company.

Contractors may be asked to provide access to basic office space, production records, repair records, calibration records, and/or activity-specific personal protective equipment (PPE), equipment, tools, and instruments required to verify contractor performance. The results of performance monitoring and assessment will be shared with the contractor as soon as practical so that mitigation of deficiencies or plans for further improvement of performance can occur as soon as practical.

7.3 Infrastructure

The operating company shall have ultimate responsibility to identify, provide, and maintain the infrastructure required to support the effective implementation of the QMS.

Guidance

The infrastructure, which is either provided directly by the operating company or a contractor, should include:

- *Access to required power and water resources;*
- *Right of way (ROW) workspace and related access to the ROW;*
- *Project management, supervision, and supporting services workspaces including related office technology;*
- *Construction, testing, and inspection equipment and technology;*
- *Secure equipment and pipeline materials storage facilities; and*
- *Space or facilities for other supporting services, if applicable, including temporary housing, food services, employee parking, etc.*

7.4 Work Environment

The operating company shall identify and manage the environmental, human, organizational, and security factors of the project working conditions that could inhibit the ability to meet the requirements of the QMS.

Guidance

Examples of pertinent factors include, but may not be limited to:

- *Work schedules, including consideration of likely commuting distances and availability of local food and housing resources;*
- *Weather conditions (temperature, wind, and precipitation);*
- *Naturally occurring environmental hazards (unstable slopes, susceptibility to flooding, poisonous vegetation, dangerous animals, etc.);*
- *Restrictive limitations on work activities or ROW size as a result of endangered species, contentious landowners, or other considerations;*
- *Labor/management and reporting relationships;*
- *Relationships between inspectors or auditors and the production supervision;*
- *Ease of access to additional resources, including subject matter experts or other technical support, additional or replacement equipment, or additional labor;*
- *Access to emergency response resources (medical, fire, hazardous material release, etc.);*
- *Security of ROW, materials, and equipment against theft and damage; and*
- *Timely delivery of operating company-provided pipeline materials in accordance with the project schedule.*

8.0 QMS PROJECT IMPLEMENTATION

8.1 General

Section 8.0 describes the project activities that directly support effective implementation of the QMS. Formal procedures and practices applicable to each core process include consideration of the following topics:

- Description of the objective;
- Identification of the responsible and accountable organizational element;
- Identification of resource requirements including training, qualification, or certification requirements for company staff, contractors, manufacturers, or suppliers, where applicable;
- Documentation and record keeping;
- Management of change;
- Review and validation practices to verify consistency with applicable regulations, standards, and company policy and procedures;
- Objective performance measurement targets and measurement methods; and
- Scope and frequency of inspections and audits to verify that the objectives are being met, with feedback to a continuous improvement process.

Guidance

As explained in the guidance of Section 5.2, the operating company may choose to group routine construction activities with a limited work scope into one "project" if they are sufficiently similar. Section 8.1 may be utilized to assess similarity. For example, grouping of activities into one project may not be appropriate if a new supplier or contractor is being utilized, the design conditions are significantly different, or if the jurisdictional regulations are not the same.

8.2 Project Quality Risk Management

The operator shall identify the risks, or probability of quality events and their consequence, associated with failure to meet the objectives of each core process. Risks should be managed through monitoring, controlling, or minimizing the probability and/or consequences. Effective project quality risk management relies upon the ability to identify potential sources of deviations or deficiencies and then to develop strategies to prevent or mitigate each. While procurement, manufacturing, fabrication, and construction tasks are required for each project, the associated QA/QC requirements for each may be scaled, as described in Section 8.3, below.

Guidance

While classical risk management considers the frequency of an event and the consequences of each event, in the context of a QMS the risk considers mainly the consequences of the deviation or deficiency on the ability to meet quality-related objectives. Both the immediate and long-term quality risks should be identified and addressed.

Quality risks can be project specific, but most projects share several common risks, including, but not limited to, the following:

- Design and materials selections are based on erroneous or incomplete inputs, or are inappropriate based on lack of experience with the intended service conditions or operating environments;*
- Changes in materials, design, or procedures are not adequately communicated thus preventing modification and implementation of related quality management tasks;*
- Schedules fail to account for the time required to implement adequate QA/QC/inspection tasks and to address the quality deficiencies that are discovered. As a result QA/QC /inspection is not performed with adequate diligence because it is considered to be less critical to achieving project deliverables;*
- Suppliers and contractors are not adequately vetted or qualified and are not fully committed to or able to comply with the specified quality requirements;*
- Organizational structures result in potential conflicts of interest between cost control, productivity, and quality;*
- There is not adequate identification of key contacts for specific quality-related issues and responsibility and accountability for quality-related issues is not assigned to specific individuals;*
- Documentation requirements related to material sources, fabrication, inspection, and testing are not fully developed or met, resulting in a lack of an adequate "paper trail" to support root cause analysis of quality deficiencies;*
- Materials control is inadequate resulting in the wrong material being issued and used even if the materials selection task was performed adequately;*
- Appropriate inspection tools and instruments are not provided to inspectors resulting in their inability to confirm conformance with quality specifications;*
- Company staff and employees of the contractors and suppliers are not adequately trained to detect, document, and mitigate quality deficiencies;*
- Weaknesses in ethics training, supervision and audit systems allow unscrupulous staff to personally gain from circumventing QMS requirements; and*
- No mechanism exists for periodic in-process review of quality management issues and feedback of results into the system, i.e., no mechanism for continuous improvement of the QMS exists while the project is in progress.*

The extent of prevention or mitigation applied to each risk should be related to the potential consequences associated with each risk. For example, if a task is not performed to the intended level of quality what is the potential severity of:

- Unplanned costs associated with reworking when the deficiency is detected later in the construction, inspection, and testing process? An example of this would be the impact on schedule, construction costs, and potential lost pipeline operation revenue associated with finding a deficiency and correcting it, even if it is discovered before a failure occurs.*
- Costs associated with increased regulatory scrutiny on the current project or future projects resulting from a failure or discovery of an avoidable deficiency?*
- Unplanned costs associated with property damage resulting from a failure?*
- Damage to public relations resulting from a newsworthy failure?*
- Safety risk associated with a failure directly resulting from insufficient quality?*
- Environmental risk and related unplanned monetary and reputation costs associated with damage to sensitive environments? This would be influenced by the product being transported as well as the characteristics of the local area impacted by a failure.*

An example of a project quality risk that may be identified is the potential receipt of sub-standard pipe due to the use of a pipe mill that has not previously been utilized by the company. To manage this risk, the mill may be pre-qualified for the project and additional resources sent to the mill for surveillance during manufacturing to identify quality issues prior to receipt of materials.

8.3 QMS Scalability

The quality management requirements for each project shall be commensurate with the identified project quality risks and complexity.

Guidance

Once the project quality risks and prevention/mitigation options are identified, the QMS components can be scaled as applicable. The term "scalability" in relation to the QMS applies to the project-specific quality requirements. While no core aspect of the QMS should be removed, the level to which they are applied should be commensurate with the quality risks and complexity. Examples of factors that affect the project complexity include the size of the project, flexibility of schedule, contractor experience, terrain, proximity to populous or environmentally sensitive areas, and whether new technologies or materials are being utilized. Higher project risk or complexity will warrant more auditing and control from the QMS. For example, a low-risk project may rely on radiographic inspection of the girth welds performed by an ASNT SNT-TC-1A Level II inspector, while a high-risk or complex project may require an additional review of radiographs by an ASNT SNT-TC-1A Level III inspector.

8.4 Pre-Construction Considerations

8.4.1 Planning and Review

The pre-construction planning process shall include consideration of, but is not limited to the following:

1. Regulatory and statutory requirements;
2. Permitting processes;

3. Anticipated land use;

Guidance

Land use may include development, land use change, population growth in the area of the planned pipeline ROW, potential changes to nearby pipelines/utilities (e.g., new crossings or changes in service of an existing pipeline in the same ROW), proximity to freeways and expressways, etc.

4. The expected normal operating conditions;

Guidance

Examples include but are not limited to the type, composition, specific gravity (density), and direction of product being transported, as well as the flow rate, pressure, pressure cycling, and temperature.

5. The likely upset conditions or unexpected excursions in operating conditions;

Guidance

Examples include but are not limited to start up and shut down, pressurization and depressurization, surge, unusual pressure cycling, pressure excursions, the presence of abnormal axial strains related to ground deformation (subsidence, seismic faults, unstable slopes, etc.), and susceptibility to vortex shedding.

6. The compatibility of pipe and components with the product to be transported;

Guidance

Examples of potential compatibility issues include the effect of changing fluid temperature, composition, or pressure resulting from introduction of gas from new sources (including LNG facilities), gradual production reservoir souring, or introduction of gas with greater hydrogen content or corrosivity. Elastomers used in miscellaneous components may be particularly susceptible to degradation or changes in performance resulting from changes in fluid characteristics. Steel toughness can change dramatically when exposed to lower temperatures. Increased hydrogen or hydrogen sulfide content can influence susceptibility to cracking.

7. Anticipated testing and inspection protocols, including during construction and during operation;

Guidance

Examples include plans for maintenance pigging (cleaning, dewatering), in-line inspection, pre-commissioning pressure testing, etc.

8. Pipeline marking, one-call registration (including pipeline siting and contact information), and emergency-responder communication processes and timing;

Guidance

Permanent pipeline marking must be complete prior to commissioning, but the company may choose to perform temporary marking during the planning or construction phases of the project. Local one-call centers and emergency-responders must be notified of the pipeline construction timing, planned siting, and emergency contact information prior to the start of construction. 49 CFR 192 and 49 CFR 195 includes requirements for pipeline marking, public awareness plans, damage prevention programs, and emergency plans.

9. Post-commissioning protection of the pipe, including a properly designed corrosion mitigation system, a cathodic protection (CP) system, as applicable, damage prevention measures, as applicable, and any elective post-commissioning monitoring;

Guidance

Examples of damage prevention measures include permanent line markers, warning mesh, or other appropriate means.

10. Identification of expected integrity threats and understanding of applicable prevention and mitigation methods;

Guidance

Examples include threats associated with the terrain or physical characteristics of the pipeline route, corrosion threats, etc.

11. Identification of any special environmental considerations, that raise the risk associated with a failure of the pipeline or may impact frequency of access to the pipeline;

Guidance

Examples include, but are not limited to, proximity to roadways, waterways, or underground structures; proximity to endangered plants or animals; or seasonal changes.

12. Identification of crossings and HDDs to understand materials requirements and scheduling impacts;

13. The likelihood that contractor resources in the local geographic area can be matched with the resources required to produce the deliverables;

Guidance

For example, consideration should be given to unusual or unique fabrication practices and the availability of experienced fabricators for either corrosion resistant alloys or for very high yield strength piping. The construction resources may be operating company or contractor personnel.

14. The need for materials testing before the materials are selected and the time required for the testing, if materials and service conditions are outside of current expertise;

15. The lead time required to procure, inspect, and accept project materials after material selection and design decisions are made; and

16. The project completion date.

The findings for each applicable consideration shall be documented to facilitate review either after the project completion or after some time of pipeline operation to determine if the pre-construction planning process was reasonably effective, as applicable. The retention period shall be established by the operating company

Guidance

An important consideration in the design and materials selection process is the project schedule and the impact of the potential adverse findings for each of the above considerations on the ability to meet the preferred commissioning date. Failure to account for realistic effects of adverse findings in the above considerations results in overly restrictive, inflexible schedules for completion of various tasks and deliverables with a potentially adverse effect on quality.

The QMS process should include provisions for verifying that each of these 15 considerations, and any additional company-specific considerations, is addressed by a subject matter expert (SME). Each of the 15 considerations may warrant a different level of verification and validation after initial analysis by an SME. The project manager or his designee should determine the appropriate level of verification and validation to be conducted for each consideration after the initial analysis is complete. That project manager should also designate who is responsible for the verification and validation.

8.4.2 Regulatory and Statute Requirements

Contractors and suppliers shall be informed of the applicable regulatory and statute requirements, and are responsible for meeting all applicable requirements.

Guidance

Consideration of regulatory requirements was listed as a planning consideration in Section 8.4.1. Applicable regulatory requirements can include but may not be limited to federal pipeline safety regulations (i.e., 49 CFR Part 192 and Part 195), state regulations, environmental agency regulations, county or city regulations, or public utility commission regulations. Compliance with these regulations is mandatory but compliance alone may not achieve the level of quality required for a specific project. QMS requirements may supplement but may not conflict with, remove or reduce any regulatory requirements

8.4.3 Additional Requirements

The company is responsible for imposing additional requirements that supplement regulatory or statute requirements to verify that the appropriate level of quality is obtained and that the design is suitable for the intended service conditions. Contractors and suppliers shall be informed of the applicable company requirements and are responsible for meeting these requirements.

Guidance

Industry consensus standards such as ASME B31.4, B31.8, API 1104, and ASME Section IX are examples that often serve as the basis for company specifications. Note that in some cases, portions of the consensus standards are referenced directly in regulatory requirements, and therefore compliance with those provisions is mandatory. Consensus standards may either provide various technically acceptable options or they may not adequately address all project-specific conditions. In those cases, the company specifications often will indicate a preference for one option over others and may impose requirements that exceed the requirements of either the consensus standards or the regulations. When company requirements exceed those of the regulations or the consensus standards it is important to recognize that contractors and suppliers may be unfamiliar with the additional requirements. The company should indicate the hierarchy of specifications, standards, and procedures to facilitate resolution of conflicts between industry consensus standards and company procedures or specifications. An example is "In the event that conflicts are found between company standards and industry standard XXX, the discrepancy shall be reported to [identify the company position here] and the more conservative of the requirements shall be applied."

8.4.4 Design Control and Verification

The operating company shall develop, document, and apply design control procedures. The design control procedures shall not be limited to design of the pipeline itself. The control procedures shall also cover all associated components, equipment, systems, or other items that will affect the integrity of the pipe and system.

Guidance

The objective of design control and verification is to confirm that designs meet applicable regulatory requirements, company procedures, and project specifications.

The design control procedures should include:

- Identification of inputs required for the design;*
- Descriptions of the design process deliverables, including documentation requirements;*
- A design review and verification process, including designation or description of the resources required for the review that are separate from the resources used for development of the design, and documentation procedures applicable to the review; and*
- Management of change (MOC) process applicable to design changes.*

The associated components, equipment, systems, or other items are specific to each construction project. Examples include pressure monitoring systems, CP systems, leak detection systems, and corrosion monitoring systems. In the case of a CP system, an example of design verification includes the following:

- *Cathodic protection design objectives;*
- *Considerations for selecting the type of cathodic protection system (galvanic or by impressed current);*
- *Specification of data requirements;*
- *Total cathodic current determination;*
- *Impressed current anode ground beds, type and location;*
- *Total resistance determination;*
- *Impressed current cathodic protection rectifiers, type and size determination;*
- *Electrical connections*
- *Galvanic anode systems, type and location;*
- *Electrical isolation devices, type and location;*
- *Cathodic protection monitoring, types and location; and*
- *Interference currents mitigation system, types, and location.*

In addition to verification of the design prior to construction, the project specifications should be developed to meet the design requirements to facilitate the high quality and fitness for purpose of installed components/ systems.

8.5 Contractors and Suppliers

Contractors and suppliers shall meet the specified quality standards. Additionally, the operating company shall verify that selected contractors and suppliers have the resources and commitments to meet specified quality standards and that the deliverables from those contractors and suppliers do, in fact, meet the specified quality standards. To support that goal, the operating company shall develop and apply a contractor and supplier qualification process, supplemented by an appropriate level of in-process audits and verification of quality. The qualification process and in-process audits may be performed by appropriate subject matter experts of the operating company or may be supplemented with or delegated to appropriate independent contractors. The extent of the qualification and audit processes shall be commensurate with the relationship of the deliverable to the success of the project and the risk of receiving substandard deliverables. The frequency and scope of the audits should be modified to reflect observed performance and quality.

The operating company shall also specify content to be included in request for proposals (RFPs), bids, purchase orders, and other the procurement documentation to verify that appropriate emphasis on quality is included and that appropriately detailed records of the contractor or supplier selection and material and services procurement process are maintained.

Guidance

Companies have traditionally written specifications for their projects, provided those specifications to the contractors, and the contractors have been building projects in accordance with the specifications. Companies have traditionally provided inspection services, and have been responsible to assess the inspection services to verify the work was done correctly and to specification².

Pre-qualification of contractors and material suppliers for pipeline construction projects is the process of verifying a contractor is suited to supply the material or perform the task they could be assigned. Pre-qualification, when utilized, aids in the development of an approved vendors list, as explained in Section 8.5.1, below. Creating and performing a thorough pre-qualification process can be one option to facilitate timely, high quality services from a contractor.

Pre-qualification of contractors and material suppliers for pipeline construction projects generally

² The INGAA Foundation, Overview of Quality Management Systems – Principles and Practices for Pipeline Construction, Final May 1, 2012

follows processes and procedures established by each operating company. In the case of engineering, procurement, and construction (EPC) contractors, this process may be established by the EPC company and adopted by the owner/operator. In general, the process begins with a Request for Information (RFI) from potential vendors, an audit process to confirm capability, and subsequently a formal Request for Proposal (RFP) and bid process based upon the customer's detailed specifications for the goods or services.

The pipe mill or material manufacturer (supplier) should be thoroughly audited to a set of company standards before being awarded a bid to manufacture. Some of the information gathered from supplier should include at a minimum certifications held (API, ASME, ISO, etc.), copies of applicable codes and standards, insurance details, HSE (health, safety and environmental) management systems, HSE statistics, main customers, average project size (monetary and volume), equipment list (make, model, year, etc.), records for similar work previously performed, QA/QC or QMS, material traceability, and internal verification processes. It should be made clear to the supplier that inspection and final quality of the product is their responsibility, not the responsibility of third party inspectors who may or may not be assigned to oversee the work. Once a supplier has completed the prequalification in a satisfactory manner a detailed HSE prequalification should then be performed. Once the contract has been awarded the supplier should be continually monitored to track schedule, quality, and cost.

Vendors, suppliers, and manufacturers of line pipe, fittings, components, and equipment should be qualified in accordance with the company's QMS. This qualification should extend to raw material suppliers and subcontractors as appropriate to the situation. Third party distributors who re-sell materials present a unique situation since they have no or limited role in the manufacturing process. Third party distributors or resellers should be able to provide sufficient documentation and records to substantiate qualification of the original manufacturer and traceability of materials. For line pipe, fittings and components qualification should include consideration of the following criteria;

- Traceability of raw materials, consumables and finished materials;*
- Quality control of raw material (steel, skelp, plate, component parts);*
- Manufacturing process, standards, and specifications;*
- Manufacture capability and capacity;*
- Qualification of subcontractors, parts suppliers and consumables;*
- Inspection and testing capability inclusive of NDT;*
- Nonconformance reporting, material identification and segregation; and*
- Document control and record keeping.*

Pipeline construction contractors should be audited in a similar fashion with an equivalent set of standards. Due to the broad geographic nature of most pipeline projects, additional consideration should be given to sources of major equipment and labor. For example, if the majority of construction and pipe handling equipment is to be rented or leased, the source of equipment, rental terms and conditions, and capability of the rental company should be assessed. Similarly, the use of local or union labor should be evaluated and all applicable labor contracts and agreements identified. The contractor's QMS should include provisions for training of local labor and/or the provision of project specific specifications and requirements. Resumes of key contractor personnel may be requested along with relevant experience on similar projects.

Depending on the scope and nature of the project, the company may elect to perform legal and/or regulatory due diligence on prospective contractors. Evidence of past litigation, claims, liens, tax payments, environmental permit compliance, OSHA citations, etc. may be reviewed to verify the contractor can adequately complete the scope of work without limitation or encumbrances.

8.5.1 Approved Vendor List

If approved vendor lists are utilized, modifications shall follow the MOC process, as described in Section 5.4, above.

Guidance

Maintenance and use of an approved vendor list is recommended. Following qualification/ approval of a particular vendor, contractor, manufacturer or supplier, the company typically establishes an approved vendor list for specific products and services. This list may include previously qualified vendors and may need to meet certain controls based on the internal requirements of the company. These requirements may include a minimum number of vendors based on the value or scope of a project, requirements for local labor, and/or union agreements if applicable.

Approved vendor lists are maintained through a process of regular audits and performance on previous projects. The company's QMS process should provide for periodic audits and performance feedback to facilitate review of the approval status of contractors following a given project. All outstanding NCRs, performance issues, claims and disputes should be resolved prior to or in conjunction with awarding future work.

In the event that a previously approved vendor is purchased, merges or acquires another vendor, previous audits should be reviewed and the approval status updated taking into account all entities involved in the new organization. Care should be taken to confirm unapproved subsidiaries or divisions are not included in the subsequent RFP process or materially participate in services awarded to an approved contractor or vendor.

The approved vendor list should include not only prime contractors, but should specify approved subcontractors, raw material suppliers, inspection contractors, transportation companies, etc. Any changes to subcontractors, material suppliers, etc. during the approval process, RFP or bid process should be addressed within the company's QMS and trigger the pre-approval or audit if necessary.

8.5.2 Bid Process and Evaluation

If a bidding process is utilized, the quality policy, objectives and metrics for the project shall be communicated to all prospective bidders as part of the initial RFP.

Bidding companies shall be required by the RFP to clearly differentiate third party roles and responsibilities including inspection, non-destructive testing (NDT), and/or surveillance.

Guidance

Bid processes are generally contained with an owner/operators corporate governance and accounting policies. Each company will have established processes for the solicitation of bids, review of bid documents and awarding of contracts. The company's QMS should reference these processes and associated procedures to verify all internal controls are adequately met. In addition, the bid process benefits from consideration of quality objectives during solicitation of bids and bid review.

The formal RFP should include project specific specifications, drawings, maps and other information to present a clear picture of the desired asset upon completion of the project. The RFP should also include the project schedule and specific deliverables relative to the schedule. Quality metrics (KPIs) and the expected inspection regime should be included to allow the contractor to identify QMS requirements during the bid process. The purpose of identifying third party roles and responsibilities

is to identify and share the project risks in a balanced way to avoid conflict, delays and overruns later.

Contract terms and conditions included in the RFP should include a system for resolving differences between the owner/operator and contractor. This system should consider risks to project quality and dispute resolution procedures.

Requirements for pre-production and pre-construction meetings should be included in the RFP documents. This may include requests for CVs of key personnel such as the project manager, superintendent, quality manager, safety manager, foreman, and/or scheduler for example. Proposed dates and attendance requirements for these meetings should be included in the project schedule as appropriate.

Contract documents including specifications, terms, conditions and drawings should clearly and completely describe the project requirements and deliverables, including;

- Requirements for approval of procedures, processes and equipment;*
- Requirements for approval of manufacturing and testing plans;*
- Requirements for approval of construction and fabrication drawings;*
- Requirements for training or qualification of personnel; and*
- Quality management system requirements.*

Evaluation of the quality aspects defined by the company shall be included in the review of bids. At a minimum, the contractors'/suppliers' inspection and test plans (ITPs) for the various activities undertaken during their scope of work for the pipeline shall be reviewed for adequacy, as well as the ability of each contractor/supplier to competently execute the ITPs. Additionally, the use of subcontractors shall be indicated in the contractor's proposal and details of how the verification of subcontractor's quality shall be shown.

Guidance

The contractor's experience with similar construction projects should be considered during the bid evaluation process. The probability of failing to meet objectives for construction quality increase when contractors are relatively inexperienced with projects of similar scope and schedule. It is important that the project work scope be compared and contrasted with the details of the contractor's experience.

Bid documents should clearly show that the contractor demonstrates an understanding of QMS and provide sufficient detail to assess their approach to the project within the framework of the QMS provided during qualification.

8.5.3 Exceptions and Contract Terms

Exceptions to the company's scope of work, specifications, schedule and/or contract terms and conditions shall be clearly identified. Exceptions raised following award of the contract shall be handled by the MOC process, as described in Section 5.4, above.

Guidance

Each exception should be addressed in writing with the contractor or vendor prior to award of the contract. Exceptions not addressed create the potential of future conflicts which risk delaying the project schedule and/or increasing overall cost. The tendency to address exceptions during pre-construction or pre-production meetings should be avoided.

The contract terms shall cover the quality aspects defined by the company. Re-work responsibility shall be addressed. Additionally, the contract terms shall address the required processes and approvals for subcontracting work.

Guidance

Contract terms and conditions are negotiated based on factors unique to each owner/operator and contractor. To promote quality of the finished pipeline and the overall success of the project, the final terms and conditions should contain provisions for the following QMS elements:

- *QMS requirements as specified in Section 6.2*
- *QMS Audit responsibilities*
- *Disposition of nonconformances or audit findings*
- *Control of subcontractors and suppliers*
- *Project close out QMS documentation*

Re-work should be performed in response to documented nonconformances and should follow the NCR process. The NCR process provides a mechanism to identify how the nonconformance will be addressed and assign responsibility for re-work or remediation, according to the contract terms. Proper documentation of all nonconformances allows for the identification of sub-standard materials and practices and aids in root cause analyses, as applicable. Consideration should be given to the post-construction inspections required by the operating company to identify all necessary re-work prior to contractor demobilization.

Additionally, the contract terms shall address the communication process. Communication of the QMS, project specifications, design standards and related material shall be specified in the contract documents to enable all parties involved in the construction process to have access to the materials necessary to facilitate a successful project. Changes to the QMS or project specifications shall be managed through the MOC process, as described in Section 5.4, above, to facilitate communication to all stakeholders.

The communication process, as defined in the contract terms, shall enable the prompt communication of any identified quality issue, root cause, contributing factor(s) and required remedial action to affected stakeholders to facilitate identification and mitigation of potential issues throughout the project.

Guidance

It is recommended that the owner company is allowed to directly communicate with contractor and all subcontractors as needed with regards to quality issues. Additionally, it is recommended that any subcontractor can directly contact the owner company with quality issues.

Adherence to specifications and standards is central to achieving project objectives, and as such should be known to all responsible parties including but not limited to management and supervisory personnel, subcontractors, suppliers and inspectors.

The contractor's proposal should clearly identify the point of contact for quality management implementation and all key staff to be included in QMS communications. Similarly the owner/operator or EPC should clearly identify responsible parties for the purpose of QMS communication. Consideration should be given to a formal document management process to facilitate control of revisions and findings that require resolution.

The communication plan should include provisions for quality issues identified during project execution that may have bearing on other aspects of the project. For example, welding deficiencies associated with a specific welding procedure should be communicated to all spreads, fabricators, suppliers or trades using the procedure.

8.5.3.1 Risk sharing and Warranties

The use of risk sharing contracts shall not substitute for adequate financial qualification of contractors or substitute for the owner/operator's responsibility to inspect and accept the finished product. Additionally, Warranties shall not be considered a replacement for inspection and verification during construction.

Guidance

The use of risk sharing mechanisms within construction contracts is gaining widespread acceptance in the pipeline industry. The use of lump sum contracts, unit pricing, cost not to exceed and incentive programs are designed to share inherent project risks between the owner/operator and the construction contractor. While most of these methods are based on financial and schedule risk, quality can and should be included in any consideration of risk sharing contracts. The overall intent is to allocate the risk of unknowns to provide for a balanced contract that encourages innovation, communication and cooperation. The overall objective being to complete the project to scope, on schedule and at a fair price.

Examples of unknowns that can influence the selection of the contract model include but are not limited to:

- *Weather and climate*
- *Permitting and local regulations*
- *Environmental and/or cultural resources*
- *Labor standards and practices*
- *Routing and right of way concerns*
- *Civil unrest or demonstrations*

Similarly, risk sharing contract structures should not take the place of a commitment from both parties to the goals of the QMS. Any use of risk sharing contracts should incorporate the goals and objectives of the QMS as measures of performance.

The use of warranties in pipeline construction generally applies to manufactured materials and components. Warranties should be considered for high value equipment, or equipment and materials which are critical to the safety or performance of the asset. Warranties do not replace the QMS or quality control during the manufacturing process, rather the warranty provides assurance that the material or component will be repaired or replaced, or financial compensation will be provided, should an issue develop during the warranty period.

8.5.4 Project Execution Plans

A Project Execution Plan (PEP) shall be prepared by each supplier or contractor, when required by the operating company, and shall include how the operating company's QMS will be applied to the project. The format and level of detail in the PEP shall be commensurate with the level of risk related to the product or service, at minimum. The PEP shall also demonstrate compliance with applicable regulatory and statute requirements and company specifications. The PEP should cover all activities required to complete the work scope. Additionally, the PEP should include an individual quality plan for each supply, deliverable, or construction activity.

Guidance

It is recommended, at minimum, that the operating company require PEPs from suppliers of pressure-carrying pipe and components, as well as the construction contractor(s). The individual quality plans in the construction contractor's PEP can be utilized to disseminate pertinent quality information to the field personnel for each activity.

The PEP should cover, but not be limited to, the following activities required to complete the work scope:

- *Safety, reliability, and risk analyses;*
- *Fabrication and construction, including transportation, as applicable;*
- *Inspection and testing;*
- *Internal and external audits;*
- *Nonconformance identification, mitigation, and preventive actions; and*
- *Continuous improvement.*

The individual quality plans may be contained within the PEP, or the PEP may reference separate documents which contain the individual quality plans. The individual quality plan for each supply or construction activity should cover the following, at a minimum:

- *A description of the activity;*
- *The relevant, documented procedure;*
- *Minimum personnel qualifications and training requirements for those performing and verifying the activity;*
- *Verification methods, including the relevant inspection and test plan (ITP) as applicable; and*
- *Record keeping requirements, including applicable inspection forms.*

Section 8.8.3 can be used for reference in development of individual activity quality plans by the contractor.

The owner company shall be responsible for reviewing the PEP and individual quality plans for compliance with the QMS and other applicable requirements. Following review and approval, the applicable quality plan shall be provided to all responsible parties, including applicable field personnel, to enable project activities to be performed in accordance with the requirements of the QMS and PEP.

8.6 Project Management

Guidance

A project consists of a set of activities that support generation of a specified deliverable or deliverables. The activities are designed and managed so that the deliverables meet the specified boundary conditions related to applicable regulations, quality, schedule, and cost. To support that objective, the project typically consists of a number of sequential and/or simultaneous tasks and subtasks each having their own deliverable, cost, and schedule. The project, tasks, and subtasks are actively managed and documented to enable and promote meeting the expectations for the deliverables and improve the ability to use the experience gained from the project to facilitate even more effective project management in the future.

8.6.1 Organizational Stakeholders

All organizational units with an appointed management representative, as described in Section 6.1.4.2, above, shall also appoint a representative for each construction project, as applicable. The organizational stakeholders required for each project shall be commensurate with the identified project quality risks and complexity.

Guidance

This promotes a project decision making process that considers input from all organizational units which may be affected by the decision.

8.6.2 Planning

The deliverables of the project planning process may consist of a specification of the individual tasks, the project execution plan (PEP) and associated individual quality plans, schedules, including critical paths, budget, and labor and non-labor resources needed to achieve the project objectives. Elements of the planning process may be waived by the operating company for tasks deemed as low risk.

Guidance

The operating company may choose to perform the project planning with in-house resources or may choose to delegate the planning process to a contractor. In either case, a critical consideration is development of control and documentation practices that promote and verify that quality objectives are met and that variances from plan or nonconformances represent opportunities for continuous improvement.

8.6.3 Project Change Control

Changes and modifications to the PEP(s) shall be documented and communicated in accordance with the established MOC process, described in Section 5.4, above.

Guidance

For complex projects, project planning can be an iterative process by which initial estimates of schedules, labor and non-labor resources, and budgets are periodically refined as more details of the project scope and plan are developed. The refinements or changes should be reviewed, verified, and approved by the operating company before implementation regardless of whether the changes are initiated by company or contractor staff. The review and approval process should consider the effect of the changes on the overall project deliverables as well as the subject task or process.

8.6.4 Project Review

The operating company shall designate the format and frequency of project reviews, and shall include relevant suppliers and contractors. The frequency may correspond with the achievement of certain significant milestones or may be made at convenient intervals of time irrespective of milestones.

Guidance

The objective of the review is to assess the degree to which the project quality, schedule, and budget conform to the plan and to identify corrective actions, if needed. Those responsible for performing the reviews should not be the same individuals directly responsible for the area of the project being reviewed. The results of the reviews should be documented and retained for reference for a time period designated by the operating company, but generally for at least the length of the warranty period.

8.7 Materials Procurement and Inspection

When required by the operating company, contractors and suppliers to the operating company shall have their own QMS which is aligned with that of the operating company's QMS. Where materials or goods are purchased on behalf of the operating company by a third party, the operating company's QMS shall be transferable and adopted by the purchaser. In addition to the QMS, manufacturing processes require additional process documentation, review, and control to facilitate meeting the required quality, schedule, delivery, and overall project objectives including performance specifications and regulatory requirements. This section is applicable to pipe manufactures, pipe coaters, double jointers, component manufactures, and other parties who provide materials or products, rather than services.

For pipelines subject to federal pipeline regulations, if used pipe is utilized on the project, it must meet the requirements of 49 CFR 192.55(b) or 49 CFR 195.114, as applicable.

Guidance

It is recommended, at minimum, that the operating company require QMS alignment from suppliers of pressure-carrying pipe and components, as well as the construction contractor(s).

The procurement of materials and goods has a significant impact on the overall quality of the finished pipeline. This includes the procurement of line pipe and components such as fittings, valves, flanges, closures, etc. As stated in Section 6.2, Contractor and Supplier Responsibility, it is essential that contractors, suppliers, and the operating company achieve alignment on quality.

The source of the pipe and fittings should be carefully considered during the materials procurement and inspection phase. Pipe and fittings purchased in mill-run quantities provide the flexibility to impose project-specific specification requirements that exceed the minimum requirements of the applicable industry specification. Additionally, the purchasing information in Section 7 of API 5L for line pipe should be included on the purchase order, as applicable. Pipe and fittings purchased from supplier's stock can often include materials that meet only the minimum requirements of the applicable industry specification. In addition, they may not have had the benefit of supplemental mill audits and inspections that are common for mill runs of pipe and fittings. If the operating company utilizes a third party for purchasing of line pipe according to API 5L, the party responsible for adherence to the purchasing information specified in Section 7 of API 5L should be agreed upon.

If used pipe is utilized for new construction projects, some documentation may not be available and the quality and mechanical properties may not be representative of current manufacturing practices. In addition, there may be undetected degradation from prior service. Therefore, testing of representative samples and careful inspection for evidence of in-service degradation or manufacturing imperfections should be considered in accordance with 49 CFR 192.55(b) or 49 CFR 195.114.

Industry references that are applicable to the procurement and inspection of line pipe and components include, but are not limited to:

- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;
- ASME B31.8, Gas Transmission and Distribution Piping Systems;
- 29 CFR 1926 Subpart H, Materials Handling, Storage, Use, and Disposal;
- API Specification 5L, Specification for Line Pipe;
- ASTM D2513, Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings;
- ASNT SNT-TC-1A, Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing;
- ASME/ANSI B16.9, Factory-Made Wrought Butt-Welding Fittings;
- MSS SP-75, Specification for High-Test, Wrought Butt-Welding Fittings; and
- API Specification 6D, Specification for Pipeline and Piping Valves.

Tables are provided below for several materials procurement and inspection activities which may assist the operating company, contractor, or supplier, as applicable, to develop a quality plan for each activity. The listed information provided may not be all-inclusive for each activity. The tables include the following information:

- Potential quality concerns that may be encountered during the activity;

- *Quality control measure options that may be selected to improve the quality;*
- *Training and competency requirements for personnel performing the activity;*
- *Inspection requirements;*
- *Training and competency requirements for the personnel performing the inspection; and*
- *Applicable records.*

The quality plan should reference the documented procedure or specification for the task. Additionally, the personnel performing the task or inspection should be able to understand and competently follow the procedure and quality plan and self-check their work, as applicable. However, self-checking is not a suitable substitute for inspection by other personnel who were not directly involved in the performance of the manufacturing or fabrication task. If quality issues are identified, work should be stopped or the component quarantined and the issue should be communicated to the appropriate personnel. Depending on the project, the personnel performing the activity and the inspection may be employed by the operating company, contractor, or supplier. Consideration should be given to multiple reviews of tasks or activities, as warranted.

8.7.1 Development of Manufacturer Procedure Specifications (MPS)

When required by the operating company, the supplier shall provide a manufacturer procedure specification (MPS) detailing manufacturing processes, quality assurance methods, quality control activities inclusive of hold points, and a description of applicable geometrical checks, material testing, and NDT. The MPS should be evaluated prior to the start of production for conformance with customer specifications, industry standards, and the intended service of the product (sour, high temperature, arctic, etc.). Exceptions to the specification taken by the supplier shall be carefully considered to assess the likelihood that the final product performance will meet the project criteria.

Guidance

It is recommended, at minimum, that the operating company require MPSs from suppliers of pressure-carrying pipe and components.

A pre-production meeting should be held to identify roles and responsibilities of the manufacturer, purchaser and/or surveillance inspectors. Meeting minutes should be retained and any agreed upon changes incorporated into the MPS prior to the start of production. When materials are to be purchased periodically from distributor's stock the expectation is that the company would have described the QMS requirements to the supplier with enough lead time that the supplier could relay the QMS requirements to the manufacturer and coordinate the preparation of the related audits, inspections, and documentation, if applicable. Distributors and suppliers should keep records of original MPS and ITP. Alternative plans for documenting quality may be necessary if some provisions of the QMS are impractical for components purchased less frequently or for those having less impact on project risk.

The MPS should clearly identify the suppliers of raw materials, consumables, and component parts, and the quality management practices utilized during the production of these materials. The MPS should also detail the requirements for and documentation provided by raw material, component part, and consumable suppliers in support of the manufacturer's QMS.

Guidance

The MPS should detail each step in the manufacturing process and describe the operation in sufficient detail to verify and confirm the process meets industry standards, regulatory requirements, and purchaser specifications. Manufacturing process controls and set points should be specified for monitoring during production. Examples of MPS sections include but are not limited to:

- *Material specifications and requirements;*
- *Raw material manufacturing requirements;*
- *Receiving of materials and consumables;*
- *Material storage and marking requirements;*
- *Forming, casting, or forging;*
- *Welding and/or assembly;*
- *Acceptance testing and NDT procedures and reporting;*
- *Geometrical measurements and reporting;*
- *Material testing and reporting;*
- *Repair and re-work procedures;*
- *Disposition of non-conforming materials;*
- *Finishing and/or coating;*
- *Finished material documentation and material tracking; and*
- *Shipping and handling.*

The MPS shall give consideration to the set-up and calibration of NDT equipment and measuring instruments used during the manufacturing process. Set-up and calibration procedures shall be established for all NDT equipment utilized during production. Corresponding personnel qualification requirements shall be listed for each operation. In the event the manufacturer utilizes NDT, measuring instruments, and/or material testing for production control, information, and/or raw material verification, the MPS shall specify the level of inspection and distribution of the results.

8.7.2 Development of Inspection and Test Plans (ITP)

When required by the operating company, materials manufacturing tasks shall have an inspection and test plan (ITP) developed to establish activities or processes subject to monitoring, documentation review, when witnessing or verification activity is required, when testing of the product is required, or when a hold is required for production to wait for authorization to proceed.

Guidance

An ITP is integral to establishing a uniform inspection and testing scheme that all parties (inspectors, manufacturers, and auditors) can follow during production. The uniform performance of activities allows for quality to be measureable, similar to tracking safety.

At a minimum, an ITP is typically developed for each pressure-carrying component of the pipeline system. The ITP should include as appropriate: testing frequency, acceptance criteria, calibration requirements, personnel qualification, reporting, and document retention. Additional information which should be included, as applicable: segregation of non-conforming material, re-testing provisions, retention of test specimens, and supplemental testing of similar materials.

8.7.3 Manufacturing Traceability

Consideration shall be given to recording the unique identification of each manufacturing component, raw material and/or consumable. Individual identifiers may be consolidated under a single identifier utilizing an appropriate tracking system. Quality control documentation such as pressure test data, NDT results, test pieces, and mechanical and metallurgical test results shall be traceable to the finished goods.

Guidance

Control of raw materials, components, consumables and finished goods throughout the manufacturing process is critical to identifying and segregating non-conforming materials. Additionally, traceability allows for the examination of similar items in the event that nonconformances are discovered.

Examples of items for consideration in a tracking system include but are not limited to pipe joints, fittings, castings, forgings, plate, skelp, welding consumables, heat numbers, lot numbers, and component serial numbers. Manufacturing and testing processes that employ more than one station, equipment operator or multiple discrete pieces of equipment should provide traceability to the finished goods. Examples include welding stations, facing machines, assembly lines, tensile testers, and/or inspection stations.

The manufacturing traceability should be maintained after the piping or component is installed. Unique identifiers assigned to pipe and components and tied to geospatial locations and manufacturing traceability records facilitate the future location and assessment of any pipe or component that is related to possible performance deficiencies. See Section 8.8.2 below

8.7.4 Materials Inspection

Material inspection and testing requirements are specified in the MPS and ITP specific to the material being manufactured and the manufacturing process. All necessary witnessing, verification, testing, and documentation review shall be completed and accepted prior to the material or product being classified as finished goods and released to the project.

Guidance

Deviations or upset conditions during the manufacturing process can lead to the introduction of defects in the finished product or the loss of traceability. Expectations for production performance such as pieces per shift, tests completed, product delivered, or repairs should be established to provide for condition monitoring. Deviations from these metrics during the manufacturing process may indicate an upset condition warranting further investigation. Hold points may be established to enable the testing and/or witnessing concurrent with the manufacturing process.

The potential quality concerns and options for quality control measures for materials procurements and inspection activities are contained in Table 8.7.4-1, below. Additionally, Table 8.7.4-1 shows the required training/competency of personnel performing the inspections, as well as the inspection and records requirements.

The "personnel performing the activity" is the material supplier or manufacturer, while the "inspection personnel" can be either the operating company, an operating company representative, or a third party inspector.

Table 8.7.4-1 Minimum Considerations for Materials Procurement and Inspection Procedures and Quality Plan

<p>Potential Quality Concerns</p>	<p>Pipe or component not fit for service</p> <ul style="list-style-type: none"> • Incorrect material(s) manufactured or supplied • Improper quality control of forming and heat treatment procedures • Material properties, such as chemical composition, mechanical properties, etc. out of manufacturing/purchaser specification • Material quantities, minimum and/or maximum lot sizes, and/or lengths (min, max, average), weights, etc. are out of specification • Material dimensions out of manufacturing/company specification, for example: <ul style="list-style-type: none"> ◦ Diameter, wall thickness, ovality, straightness, squareness of pipe ◦ Ovality, bend radius, bend angle, and wall thickness of induction bends or elbows ◦ Factory bevels and end preparation ◦ Coating thickness and adhesion • Failure to identify imperfections or defects that could impact short term or long term integrity and performance of the constructed pipeline, for example: <ul style="list-style-type: none"> ◦ Pipe wall imperfections ◦ Casting defects ◦ Weld defects ◦ Coating holidays ◦ Incorrect seals or gaskets • Failure to repair imperfections in a manner consistent with the material specification or use of on-site repair that affects warranties or prevents root cause analysis • Metal pipe magnetism concerns due to manufacturing process or shipping <p>Inadequate documentation</p> <ul style="list-style-type: none"> • Documentation unavailable or not provided with materials(s) • Incomplete documentation of traceability for raw materials, manufacturing components, consumables, and/or inspection and testing results • Incorrect marking or identification of material
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Table 8.7.4-1 Minimum Considerations for Materials Procurement and Inspection Procedures and Quality Plan (continued)

QA/QC and Mitigation Options	<ul style="list-style-type: none"> • The development and utilization of a material tracking procedure or system <ul style="list-style-type: none"> ◦ Traceability of raw materials ◦ Traceability of NDT results, material testing and repairs ◦ Quarantine plan for damaged or improper materials • Inspection of materials for adherence to specifications and for damage <ul style="list-style-type: none"> ◦ Verification of dimensions ◦ Verification of ITP conformance ◦ Verification of coating type, surface preparation and thickness • Verification of associated markings and documentation <ul style="list-style-type: none"> ◦ Verification of material markings, specifically dimensions, material, manufacturer, pressure rating/class, serial number, date of manufacture, monogram program, and other applicable information ◦ Verification of MTRs for completeness, and that all requirements for testing and inspection were met • Procedure developed for identifying nonconformances and documenting via nonconformance reports (NCRs) • Marking and segregation procedure for non-conforming materials • Criteria and procedures developed for performing on-site repairs or returning to the manufacturer/supplier • Consistent documentation procedures/forms for inspections and verifications • Third-party mill/supplier inspections
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Ability to operate manufacturing and testing equipment to produce component(s) • Ability to collect/file documentation • Ability to interpret and apply purchaser specifications/procedures • Familiar with Manufacturer Quality Policy, MPS, ITP, tracking, and quarantine requirements • Trained in repair methods and related repair limitations of the applicable specifications and standards
Inspection Requirements	<ul style="list-style-type: none"> • Inspection of manufacturing process to confirm MPS, ITP and WPS has been followed • Inspection of X% of pipe/component body, bevel, and coating • Inspection of X% of bends for ovality, bend radius, and bend angle • Verification of completed ITP and MTRs that match the component produced • Verification that materials produced were manufactured to the purchaser specifications • Visual inspection and, where applicable, NDT of on-site repairs

Table 8.7.4-1 Minimum Considerations for Materials Procurement and Inspection Procedures and Quality Plan (continued)

<p><i>Training/Competency of Inspection Personnel</i></p>	<ul style="list-style-type: none"> • <i>Understanding of purchaser specifications, MPS, ITP and WPS</i> • <i>Ability to take required measurements</i> • <i>Ability to recognize manufacturing defects and non-conforming documentation</i> • <i>Ability to recognize the completeness of applicable procedures</i> • <i>Ability to interpret and confirm NDT results</i> • <i>Ability to interpret and confirm material testing results</i> • <i>ASNT SNT-TC-1A Level I, II, or III as required</i> • <i>Ability to measure welding parameters, including voltage, current, travel speed, and in some cases heat input</i> • <i>Ability to check compliance with project WPS (consumables, time between passes, welding parameters, etc.)</i> • <i>Understanding of the proper application and maintenance of preheat</i> • <i>Personnel inspecting coating must exhibit the knowledge, skills and ability to verify effective coating application</i> • <i>NACE Certified Coating Inspector – Level 3, or other, as required</i>
<p><i>Records Requirements</i></p>	<ul style="list-style-type: none"> • <i>Inspection forms completed in accordance with ITP</i> • <i>Associated MTRs and component documentation packages, preferably stored in electronic format. These documents may be sent independently of the component, and they may contain, for example:</i> <ul style="list-style-type: none"> ◦ <i>Pipe – MTR, WPS, NDT reports, hydrostatic test records, shipping tally</i> ◦ <i>Valves – MTR, fabricator’s welding procedure specification (WPS), non-destructive testing (NDT) reports, hydrostatic test records</i> ◦ <i>Bends – MTR, WPS, NDT reports, hydrostatic test records</i> ◦ <i>Flanges – MTR</i> ◦ <i>Other components (Weldolets®, CP anodes, etc.) – MTR, manufacturer documentation, etc. as applicable</i> • <i>Abnormalities or deviations from specifications, recorded as NCR, to be addressed by quarantine plan</i> • <i>Any anomalies that were deemed acceptable and that may appear on future ILI runs should be well documented and brought to the attention of the as-built project team and operations group</i> • <i>Any repairs should be documented with regard to the type of anomaly that was repaired, the repair method used, the location of the repair and the final dimensions at the location of the repair. Results of any NDT should be recorded on appropriate reports.</i>

The manufacturer shall verify that raw material, parts and consumable suppliers under their control have the resources and commitments to meet specified quality standards and that the deliverables from those suppliers do, in fact, meet the specified quality standards.

Guidance

To support the quality goals, the purchaser should specify a supplier audit and verification process, supplemented by manufacturer testing and verification of quality during production. Examples of suppliers include steel mills, plate mills, hot strip mills, welding consumables, coatings, and component parts. Transportation and handling between various points of supply should be considered to prevent damage or contamination which could be detrimental to the finished product. The extent of the audit, testing and verification processes should be commensurate with the relationship of the deliverable to the success of the project and the risk of receiving substandard materials. The frequency and scope of testing and verification should be modified to reflect observed performance and quality. The acceptance criteria and action levels should be documented in the MPS and ITP as appropriate. Performance and quality observations should be made available to the purchaser or his designated representative to facilitate clear communication to the project team.

Material testing facilities and equipment should be identified in the MPS and ITP prior to the start of testing.

Guidance

Testing equipment should be of proper size and capacity for the material, for example, the grade, thickness and size specified. The use of sub-sized test specimens should be evaluated thoroughly prior to acceptance. The physical location of all test samples taken, cutting, machining, flattening, aging, and storing procedures should be included in the MPS and/or ITP as appropriate. Should off-site or third party testing facilities be used, consider establishing proper chain of custody procedures for all test specimens. Access to all testing facilities should be provided to the purchaser or purchaser's representative for witnessing any time project materials are being tested. Re-testing protocols should be established prior to the start of manufacturing and approved by the purchaser in advance. Production or pre-testing of materials or manufactured components conducted by the manufacturer for information or quality control should be communicated to the purchaser or representative and witnessed as appropriate.

8.7.5 Welding Inspection during Manufacturing

Guidance

Welding and joining are critical to the quality and performance of the finished product. Defects not remediated during the manufacturing process may result in failure of the pipeline during commissioning or later while in service. The design of the weld, welding consumables, and the welding process all have to be strictly controlled and adhered to.

All welding geometries, parameters and consumables shall be detailed in a Welding Procedure Specification (WPS) and approved by the purchaser prior to the start of manufacturing. Procedure Qualification (PQ) tests shall be documented prior to the start of manufacturing and essential variables monitored throughout production. Welding procedures shall be re-qualified following any change in essential variables and under any other conditions designated by the operating company. Double jointing operations shall be performed in accordance with Section 8.8.3.7.1 Welding, below.

Guidance

The WPS/PQ should be specific to all manufacturing processes including but not limited to tack, ID, OD and/or repair welding. The MPS and ITP should specify testing and inspection requirements for completed welds and consumables used during the course of production.

Industry references that are applicable to the welding of line pipe and components include, but are not limited to:

- API 1104, *Welding of Pipelines and Related Facilities*; and
- ASME Boiler and Pressure Vessel Code (BPVC), Section IX, *Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators*.

8.7.6 Non-Destructive Testing during Manufacturing

Nondestructive testing shall be in accordance with the MPS and ITP.

Guidance

The potential quality concerns and options for quality control measures for NDT activities are contained in Table 8.7.6-1, below. Additionally, Table 8.7.6-1 shows the required training/competency of personnel performing the inspections, as well as the inspection and records requirements.

Table 8.7.6-1 Minimum Considerations for Development of NDT Procedures and Quality Plan during Manufacturing

Potential Quality Concerns	<p>Pipe or component not fit for service:</p> <ul style="list-style-type: none"> • Failure to detect rejectable defects, due to: <ul style="list-style-type: none"> ◦ Selection and application of an inspection method or inspection equipment that is not suitable for detection of the flaws of interest (e.g., using magnetic particle inspection equipment to detect embedded flaws, or using the incorrect transducer or wedge angle for shear wave UT inspection) ◦ Improper fabrication and/or utilization of calibration standard(s) ◦ Improper setup and calibration of NDT equipment ◦ Inadequate inspection resolution and quality requirements caused, for example, by improper development of radiographic film ◦ Improper test sample, for example, sample location, dimensions, machining, and flattening • Acceptance of rejectable defects, due to: <ul style="list-style-type: none"> ◦ Improper interpretation of detectable indications ◦ Incomplete understanding of the acceptance criteria <p>Inadequate documentation</p> <ul style="list-style-type: none"> • Loss of traceability, for example, individual pipe joints in a testing lot • Incomplete communication of NDT results to production, which can prevent effective prevention/mitigation of conditions contributing to the generation of defects <p>Note: Personnel safety issues related to radiographic inspection should also be considered</p>
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Table 8.7.6-1 Minimum Considerations for Development of NDT Procedures and Quality Plan during Manufacturing (continued)

QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Verification and documentation of NDT personnel qualifications • Written NDT and NDT procedures approved by ACCP/ASNT Level III in place and known to relevant personnel <ul style="list-style-type: none"> ◦ Optimized for the manufacturing process and acceptance criteria applicable to the project ◦ Documented verification that the NDT procedure produces the required sensitivity to detect anomalous conditions at established thresholds • Written material testing procedure approved by purchaser and known to relevant personnel • Equipment calibration and tracking procedures • Monitoring, witnessing and verification personnel trained in NDT methods, procedures and acceptance criteria <ul style="list-style-type: none"> ◦ Documented process for identification of conditions that may warrant supplemental inspection or testing beyond specification requirements
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of manufacturer NDT procedures • Understanding of applicable industry standards, code requirements and purchaser specifications • ASNT SNT-TC-1A Level I, II, or III as required (only Level II and Level III may interpret NDT results and determine acceptance of a particular inspection)
Inspection Requirements	<ul style="list-style-type: none"> • Inspection per the requirements of industry standards, regulatory requirements and purchaser specifications as detailed in the MPS and ITP. • Supplemental inspections, as required by purchaser specifications
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of NDT procedures • Understanding of acceptance criteria contained in applicable industry standards, code requirements and purchaser specifications • ASNT SNT-TC-1A Level I, II, or III as required • NACE Certified Coating Inspector – Level 3, or other, as required • Inspectors properly trained to recognize deviations from established procedures

Table 8.7.6-1 Minimum Considerations for Development of NDT Procedures and Quality Plan during Manufacturing (continued)

Records Requirements	<ul style="list-style-type: none"> • NDT personnel qualifications • NDT procedures • Calibration and equipment identification records • Weld inspection reports <ul style="list-style-type: none"> ◦ Pipe information (joint, heat, diameter, wall thickness, etc.) ◦ Welding station (tack, ID, OD, double jointing, etc.) ◦ Welder(s) or welding operator(s) ◦ Inspection crew ◦ Nonconformities of finished weld, with associated disposition • Weld repair reports (as applicable) <ul style="list-style-type: none"> ◦ Pipe information (joint, heat, diameter, wall thickness, etc.) ◦ Original weld station and defect ◦ NDT method utilized to detect defect ◦ Repair location and length ◦ Welder(s) or welding operator(s) ◦ Inspection crew • Coating inspection reports • Any anomalies that were deemed acceptable and that may appear on future ILI runs should be well documented and brought to the attention of as-built project team and operations group.
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8.7.7 Pressure Testing during Manufacturing

Calibration and test records shall be distributed and retained in accordance with the purchaser's specifications, MPS and ITP. Units of measure shall be specified prior to production and chosen to provide sufficient resolution to achieve the desired level of accuracy.

Where pressure testing of a prototype or production piece is used in lieu of full production run testing, the manufacturer must certify the component was manufactured under a quality control system that verifies that each component is at least equal in strength to a prototype that was hydrostatically tested at the factory. The MPS shall include provisions to facilitate and verify quality through all production stages and monitoring of critical production steps such as casting, forging and/or assembly of equipment. Where seals, plugs or other devices are used that could affect the serviceability of the equipment, clear documentation and installation procedures shall be provided to the end user concurrent with or prior to delivery.

Guidance

Pressure testing during the manufacturing process provides a proof test that individual pipe joints and components meet intended operating pressure requirements. Pressure test plans and specifications should take the manufacture's method and equipment into consideration, for example end loading values, fill volume, hold time, test medium, environmental conditions, and equipment calibration. Monitoring and acceptance criteria should be established to identify any material deformation, expansion and/or change in dimensional properties following testing which might indicate substandard materials or components.

8.7.8 Surveillance during Manufacturing

Manufacturing surveillance may take the form of monitoring, witnessing or verification. The surveillance plan shall be clearly communicated to the manufacturer prior to the start of production. Surveillance personnel shall have the requisite experience and knowledge to interpret and evaluate manufacturing and testing requirements, equipment and results. Consideration shall be given to adequate access to manufacturing facilities, production records, and test results for inspectors and purchaser representatives during all phases of production, as applicable.

Guidance

Companies providing manufacturing surveillance services often utilize contract employees or free-lance inspectors who remain on site for multiple production runs and/or customers. This has the potential to create conflicts of interest, refer to Section 6.2.4.3 for guidance in managing potential conflicts of interest. Also, see the guidance for Section 8.7.1 with regard to the requirements for materials purchased from distributors instead of directly from the manufacturer.

8.7.9 Manufacturing NCRs and Dispositions

The manufacturer shall have a QMS established that addresses the identification and disposition, such as repair or disposal, of raw materials, pipe, or components that do not conform to the purchaser's specifications. Nonconformance reports (NCR) may be initiated by the manufacturer, the purchaser, or the purchaser's representative (inspectors). NCRs shall be made available to the purchaser or the purchaser's representative during and following production. NCRs shall contain sufficient detail to allow for the identification, disposition, and tracking of systemic situations and other potentially impacted materials. The manufacturer shall have processes for quarantine, marking, and segregation of non-conforming materials. Non-conforming materials shall not be identified as finished goods to avoid accidental shipment to the project.

8.7.10 Manufacturing Marking and Identification

Marking schemes should be established prior to material procurement to provide for traceability and coordination between the various project parties. Supplemental marking shall be clearly visible, weather and transportation resistant, and compatible with coatings.

Guidance

Industry standards specify minimum marking and name plate data for various materials including line pipe, fittings, and valves. The Operator's QMS should consider supplemental marking requirements specific to the project. Marking materials with bar codes, RFID tags and/or color coded striping can facilitate transportation, storage, stringing and as-built surveys, as well as traceability. Additional guidance is provided in the component manufacturing standards.

8.7.11 Transportation and Handling

The MPS shall include shipping and handling instructions specific to the mode(s) of transportation, lot size, and intermediate transfer points if applicable. Where shipping seals, plugs, packing or other devices are used that could affect the serviceability of the equipment, clear documentation and installation procedures shall be provided to the end user concurrent with or prior to delivery.

Guidance

Industry references that are applicable to the transportation and handling of line pipe and components include, but are not limited to:

- *API RP 5LT, Recommended Practice for Truck Transportation of Line Pipe;*

- API RP 5L1, Recommended Practice for Railroad Transportation of Linepipe; and
- API RP 5LW, Recommended Practice for Transportation of Linepipe on Barges and Marine Vessels.

Dunnage and strapping should be chosen to minimize transit damage including transportation induced fatigue cracking and damage to coatings, bevels, and sealing surface such as those on flanges. Inspection of shipping conditions and rigging to confirm that the shipping specification has been followed should be done before pipe is shipped and on arrival at the receipt location. In the event that materials are transferred from one mode of transportation to another while in transit, the shipping conditions should be re-inspected at the transfer point to confirm compliance with the specifications.

Consideration should be given to stack height of piping to prevent ovality. Handling considerations such as padding of fork lifts, pipe hook materials, and/or vacuum lift configuration should be specified and inspected during handling operations. Other considerations such as induced magnetism, chloride contamination, and water intrusion should be evaluated as appropriate for the project.

The potential quality concerns and options for quality control measures for transportation activities are contained in Table 8.7.11-1, below. Additionally, Table 8.7.11-1 shows the required training/competency of personnel performing the transportation activities and inspections, as well as the inspection and records requirements.

Table 8.7.11-1 Minimum Considerations for Development of Transportation Procedures and Quality Plan

Potential Quality Concerns	<p><i>Pipe or component not fit for service as a result of defects introduced during transportation and handling</i></p> <ul style="list-style-type: none"> • Purchaser transportation specification/procedure not followed • Component body, bevel, or factory coating damaged • Induced Magnetism • Product or raw material contamination • Ovality • Transportation fatigue <p><i>Incorrect or inadequate documentation</i></p> <ul style="list-style-type: none"> • Documentation unavailable upon receipt or not provided concurrent with materials(s) • Incomplete or incorrect documentation of traceability • Incorrect marking or identification of material <p><i>Lost or missing items</i></p>
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Table 8.7.11-1 Minimum Considerations for Development of Transportation Procedures and Quality Plan (continued)

QA/QC and Mitigation Options	<ul style="list-style-type: none"> • The development and utilization of a material tracking procedure or system <ul style="list-style-type: none"> ◦ Traceability of raw materials and finished goods ◦ Quarantine plan for damaged or improper materials • Inspection of materials for adherence to specifications and for damage <ul style="list-style-type: none"> ◦ Verification of dimensions ◦ Verification of lot sizes and shipping locations ◦ Verification of coating type(s) ◦ Verification of proper handling equipment and rigging ◦ Verification of dunnage, strapping, etc., conformance ◦ Verification of as-shipped and as-received condition • Verification of associated markings and documentation <ul style="list-style-type: none"> ◦ Verification of material markings, specifically dimensions, material, manufacturer, pressure rating/class, serial number, date of manufacture, monogram program, and other applicable information ◦ Verification of shipping manifests and tallies ◦ Verification of material documentation receipt • Procedure developed for identifying nonconformances and documenting via nonconformance reports (NCRs) • Consistent documentation procedures/forms for inspections and verifications
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Ability to operate handling equipment • Ability to collect/file documentation • Ability to interpret and apply purchaser specifications/procedures • Familiar with Manufacturer Quality Policy, MPS, ITP, tracking, and quarantine requirements
Inspection Requirements	<ul style="list-style-type: none"> • Inspection of handling and transportation process to confirm MPS and specifications have been followed • Inspection of X% of pipe/component body, bevel, and coating • Inspection of X% of load rigging, dunnage, and strapping • Verification of shipping tallies, lot sizes and destinations • Verification of material marking • Verification of shipping and handling procedures and specifications
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of purchaser specifications and MPS • Understanding of shipping manifests and material tallies • Ability to take required measurements • Ability to recognize material contamination, damage and non-conforming documentation • Ability to recognize the completeness of applicable procedures

Table 8.7.11-1 Minimum Considerations for Development of Transportation Procedures and Quality Plan (continued)

Records Requirements	<ul style="list-style-type: none"> • Inspection forms completed in accordance with MPS and ITP • Shipping manifests and tallies • Associated MTRs and component documentation packages, preferably stored in electronic format. These documents may be sent independently of the component. • Abnormalities or deviations from specifications, recorded as NCR, to be addressed by quarantine plan • Any anomalies that were deemed acceptable and that may appear on future ILI runs should be well documented and brought to the attention of the as-built project team and operations group
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For information on the quality concerns associated with the field-receipt and offloading of pipe and components, refer to Section 8.8.3.1, below.

8.8 Construction

8.8.1 Control of Construction and Inspection

The operating company shall plan, perform, and monitor construction of the pipeline system in accordance with established company procedures, PEPs, and individual quality plans. The procedures shall address and promote the availability and use of:

- Drawings, documents, and specifications;
- Suitable materials obtained from qualified manufacturers and suppliers;
- Qualified service providers;
- Effective inspection, testing, and quality control procedures, including documentation practices and the availability of related inspection, testing, and monitoring equipment; and
- Pre-commissioning procedures.

Guidance

Inspection of pipeline construction is required per 49 CFR 192.305 and 49 CFR 195.204. Inspections should be performed according to documented procedures by qualified personnel. Inspections may take the following forms:

- Observations of adherence to construction procedures, such as lowering-in the pipe;
- Test data collection and record keeping, such as non-destructive testing of welds; or
- Auditing of key procedure parameters, such as welding variables.

Suggested inspection and associated records requirements are provided in the tables for each construction activity described in Section 8.8.3, below. However, the information should not be considered all-inclusive. Nonconformances noted during construction inspection should be addressed using the requirements in Section 9.3, below, to allow for continuous improvement.

8.8.2 Field Identification and Traceability

Consideration shall be given to recording the position and unique identification of each system component.

Guidance

Knowing the location, and unique reference, of each pipeline system component facilitates the examination of each item in response to the discovery of substandard characteristics in like or similar components. Additionally, this information is used to maintain traceability in pipeline records for the pressure-carrying components. Examples include pipe and fitting heat numbers, lot numbers, and component serial numbers. Where unique identifiers are not provided by the manufacturer, the operating company may devise a permanent marking system consisting, for example, of low stress stamp marks, indelible paint, bar coding, or tags, as applicable. The identification number, related manufacturing and quality control documentation, and record of the location of the components should be retained for the life of the pipeline.

8.8.3 Quality Plans for Construction and Installation Activities

A specific quality plan shall be developed for each construction activity performed on the project. Refer to section 8.5.4, above, for additional information on individual quality plans. Examples of construction activities include:

- Receipt and offloading;
- Storage;
- Construction surveying and staking;
- Ditching;
- Stringing;
- Field bending;
- Fusion processes, including welding or joining of plastic pipe, as applicable;
- Non-destructive testing of welds;
- Field coating;
- Coating holiday inspection (jeeping) and coating repairs;
- Ditch padding;
- Lifting and lowering-in;
- Local pipe attachments, including the cathodic protection (CP) system and CP monitoring, and post-commissioning condition monitoring, as applicable;
- Pipe weighting;
- As-built surveying;
- Backfilling;
- Tie-ins;
- Special considerations, including horizontal direction drilling, cased crossings, on-site or off-site fabrications, and the installation of tracer wires for locating plastic pipe;
- Pre-commissioning pressure testing;
- Pre-commissioning inspections, surveys, and excavations;
- Final tie-in welds; and
- As-built documentation.

It is the responsibility of the operating company and construction contractor to identify any additional or unique activities for the company's project, as applicable. Not all of the examples are applicable to every project; some may be required by regulation while others are discretionary and may only be applicable to some high-risk projects.

Guidance

The information provided below should not be considered all-inclusive. It is the responsibility of the company and construction contractor to determine any unique quality concerns that may be applicable to each construction project. Examples of construction activities not explicitly covered in the guidance below that may be applicable to pipeline construction projects include, but are not limited to, non-fusion plastic joining techniques such as solvent cement or adhesive joints, hot tapping existing lines to join new infrastructure, and novel trenchless installation techniques.

The information below should be considered a supplement to the requirements of 49 CFR 192 and 49 CFR 195, and not as ground for non-compliance.

Tables are provided below for each listed construction activity which may assist the operating company and contractor, as applicable, to develop a quality plan for each construction activity. The listed information provided may not be all-inclusive for each activity. The tables include the following information:

- *Potential quality concerns that may be encountered during the construction activity;*
- *QA/QC and mitigation options that may be selected to improve the quality;*
- *Training and competency requirements for personnel performing the activity;*
- *Inspection requirements;*
- *Training and competency requirements for the personnel performing the inspection; and*
- *Applicable records.*

The quality plan should reference the documented procedure or specification for the task. Additionally, the personnel performing the task or inspection should be able to understand and competently follow the procedure and quality plan and self-check their work, as applicable. However, self-checking is not a suitable substitute for inspection by other personnel who were not directly involved in the performance of the construction task. If quality issues are identified, work should be stopped or the component quarantined and the issue should be communicated to the appropriate personnel. Depending on the project, the personnel performing the activity and the inspection may be employed by the operating company or a contractor. Consideration should be given to multiple reviews of tasks or activities, as warranted.

8.8.3.1 Receipt and Offloading

The pipe and components (valves, flanges, bends, CP anodes, etc.) and associated documentation are received from the vendor(s) or manufacturing facilities to the main receiving facilities or project storage yards. The pipe and components must then be offloaded from the truck, railroad car, barge, or other mode of transportation. The required documentation includes, at a minimum, material test reports (MTRs) or component documentation package.

Industry references that are applicable to the receipt and offloading of pipe include, but are not limited to:

- API RP 5LT, Recommended Practice for Truck Transportation of Line Pipe;
- API RP 5L1, Recommended Practice for Railroad Transportation of Line Pipe;
- API RP 5LW, Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels;
- API RP 5L8, Recommended Practice for Field Inspection of New Line Pipe;
- ASTM D2513, Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings; and
- 29 CFR 1926 Subpart H, Materials Handling, Storage, Use, and Disposal.

The potential quality concerns and options for quality control measures for receipt and offloading activities are contained in Table 8.8.3.1-1, below. Additionally, Table 8.8.3.1-1 shows the required training/competency of personnel performing the receipt and offloading activities and inspections, as well as the inspection and records requirements.

Table 8.8.3.1-1 Minimum Considerations for Development of Receipt and Offloading Procedures and Quality Plan

Potential Quality Concerns	<p>Pipe or component not fit for service</p> <ul style="list-style-type: none">• Incorrect component(s) received• Missing pipe or component• Material dimensions out of manufacturing/company specification, for example:<ul style="list-style-type: none">◦ Ovality, bend radius, bend angle, and wall thickness of induction bends or elbows◦ Factory bevel◦ Coating thickness• Metal pipe magnetism concerns due to factory-applied coating or shipping <p>Transportation damage to pipe or component</p> <ul style="list-style-type: none">• Company transportation specification/procedure not followed• Component body, bevel, or factory coating damaged• Fatigue of girth welds of double jointed pipe• Pipe or coating defects resulting from shipping or handling <p>Inadequate documentation</p> <ul style="list-style-type: none">• Documentation not provided with component(s)• Incorrect marking or identification of material• Insufficient documentation to maintain traceability
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Table 8.8.3.1-1 Minimum Considerations for Development of Receipt and Offloading Procedures and Quality Plan (continued)

QA/QC and Mitigation Options	<ul style="list-style-type: none"> • The development and utilization of a material tracking procedure or system <ul style="list-style-type: none"> ◦ Positive material identification (PMI) program ◦ Quarantine plan for damaged or improper materials ◦ Requirements for treatment of material that does not meet traceability requirements • Inspection of materials for adherence to specifications and for damage <ul style="list-style-type: none"> ◦ Verification of dimensional tolerances ◦ Verification of coating type and thickness • Verification of associated markings and documentation <ul style="list-style-type: none"> ◦ Verification of material markings, specifically dimensions (outside diameter, wall thickness, etc.) material, manufacturer, pressure rating/grade, and other applicable information ◦ Verification of MTRs for completeness, and that all requirements for testing and inspection were met • Procedure developed for identifying non-compliances and documenting via non-compliance reports (NCRs) • Documented repair procedures for pipe, components, and coating • Consistent documentation procedures/forms for inspections and verifications
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Ability to operate equipment to offload and move component(s) • Ability to collect/file documentation • Ability to interpret and apply company specifications/procedures • Familiar with material PMI, tracking, and quarantine • Ability to recognize and judge the acceptability of apparent damage to pipe, components or coating
Inspection Requirements	<ul style="list-style-type: none"> • Inspection of shipping conditions and rigging to confirm shipping specification has been followed • Inspection of X% of pipe/component body, bevel, and coating • Inspection of X% of bends for ovality, bend radius, and bend angle • Confirmation of receipt of completed MTRs that match the component received • Documentation that confirms materials received were manufactured to the company specifications • Inspection of repairs of various kinds • Confirmation that traceability is maintained
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company specifications • Ability to take required measurements • Ability to recognize manufacturing defects and non-conforming documentation • Ability to recognize the completeness of applicable procedures • Ability to perform inspections applicable to various repair procedures and to judge the acceptability of the repair

Table 8.8.3.1-1 Minimum Considerations for Development of Receipt and Offloading Procedures and Quality Plan (continued)

Records Requirements	<ul style="list-style-type: none"> • <i>Inspection forms completed at the receipt of materials</i> • <i>Associated MTRs and component documentation packages, preferably stored in electronic format, sufficient to maintain traceability. These documents may be sent independently of the component, and they may contain, for example:</i> <ul style="list-style-type: none"> ◦ <i>Pipe – MTR, shipping tally</i> ◦ <i>Valves – MTR, fabricator’s welding procedure specification (WPS), non-destructive testing (NDT) reports, hydrostatic test records</i> ◦ <i>Bends – MTR, WPS, NDT reports, hydrostatic test records</i> ◦ <i>Flanges – MTR</i> ◦ <i>Other components (Weldolets®, CP anodes, etc.) – MTR, manufacturer documentation, etc. as applicable</i> • <i>Abnormalities or deviations from specifications, recorded as NCR, to be addressed by quarantine plan</i> • <i>Any anomalies that were deemed acceptable and that may appear on future ILI runs should be well documented and brought to the attention of the as-built project team and operations group</i> • <i>Documentation of repairs in the appropriate format</i>
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8.8.3.2 Storage

The pipe and components (valves, flanges, bends, CP anodes, etc.) and associated documentation are stored in warehouses or project storage yards until they are needed for installation or shipment to the ROW.

Industry references that are applicable to the storage of pipe and components include, but are not limited to:

- *ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;*
- *ASME B31.8, Gas Transmission and Distribution Piping Systems; and*
- *29 CFR 1926 Subpart H, Materials Handling, Storage, Use, and Disposal.*

The potential quality concerns and options for quality control measures for storage activities are contained in Table 8.8.3.2-1, below. Additionally, Table 8.8.3.2-1 shows the required training/competency of personnel performing the storage activities and inspections, as well as the inspection and records requirements.

Table 8.8.3.2-1 Minimum Considerations for Development of Storage Procedures and Quality Plan

Potential Quality Concerns	<p>Pipe or component not fit for service due to:</p> <ul style="list-style-type: none">• Improper equipment or rigging• Improper support, stacking, or stack height of pipe, fittings, or components• Damage to pipe body or pipe ends coating or component from contact or environment, examples include:<ul style="list-style-type: none">◦ Denting◦ Gouging◦ Ovality due to stacking overburden• Corrosion of pipe/component body from stagnant water• Damage to or corrosion of factory bevels• Improper storage of CP system components, including galvanic packaged anodes or anode carbonaceous backfill material, or damage to the electrical insulation of CP cables <p>Inadequate documentation</p> <ul style="list-style-type: none">• Insufficient documentation to maintain traceability
QA/QC and Mitigation Options	<ul style="list-style-type: none">• Follow company specification for storage to avoid damage when handling and/or stacking• Follow specification or best practice for handling, stacking, and storage of pipe/component to prevent coating damage• Establish how long coating or component can be exposed to uncontrolled environment• Seal or protect inside of pipe/components and bevels• Consistent documentation procedures/forms for inspections and verifications• Proper storage of CP system components, including:<ul style="list-style-type: none">◦ Galvanic packaged anodes stored in waterproof containers◦ Follow manufacture specifications for storing carbonaceous backfill for anodes◦ Protect CP cables from external damage (including UV)
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none">• Ability to operate equipment required for pipe and component storage• Ability to interpret and apply company specifications/procedures<ul style="list-style-type: none">◦ Proper stacking of line pipe and components◦ Protection of bevels and coating◦ Environmental concerns during storage (corrosion, UV exposure, etc.)
Inspection Requirements	<ul style="list-style-type: none">• Confirmation that storage conditions and practices meet the company storage procedures• Confirmation that traceability is maintained
Training/Competency of Inspection Personnel	<ul style="list-style-type: none">• Understanding of the company storage procedures• Ability to take required measurements
Records Requirements	<ul style="list-style-type: none">• Inspection report(s) for storage yard or facility and that specifications for storage are met• Photo documentation of proper storage• All records to be digitized and linked to pipe stored at the corresponding location, sufficient to maintain traceability• Abnormalities or deviations from specifications, recorded as NCR, to be addressed prior to use of pipe or components

8.8.3.3 Construction Surveying and Staking

At the time of construction surveying, the route selection process has been completed. Additionally, the geotechnical surveying, to determine soil conditions and environmental concerns has been carried out. These pre-construction surveys are integral to identify class locations, high consequence areas (HCAs), environmental concerns, and geotechnical concerns such as fault lines and areas with possible subsidence or liquefactions, which are considered during pipeline design. For example, the geotechnical concerns are considered with regards to stress concentrations on pipeline girth welds.

Construction surveying of the ROW is performed to stake the planned pipeline route, which includes points of inflection, elevation changes, crossings (fences, railroads, roads, streams, utilities, etc.), environmentally sensitive areas, HCAs, changes in class locations, and horizontal directional drills (HDDs). Construction surveying and staking typically occurs prior to the start of construction; however, staking may be performed again during construction if unforeseen issues occur, such as route changes due to landowner disputes. The construction survey team must coordinate with other utility owners using the one-call system to identify, locate, and mark potential utility crossings along the pipeline route.

The work area staked should be of a sufficient width to perform the construction work. Additionally, the requirements outlined in 29 CFR 1926, Safety and Health Regulations for Construction, should be considered when staking the work areas.

The potential quality concerns and options for quality control measures for construction surveying are contained in Table 8.8.3.3-1, below. Additionally, Table 8.8.3.3-1 shows the required training/competency of personnel performing the construction surveys, as well as the inspection and records requirements.

Table 8.8.3.3-1 Minimum Considerations for Development of Construction Surveying, Staking, and Security Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Inaccuracies in pipeline route mapping • Inaccuracy of points of inflection which can affect prefabricated bends and staging of materials • Intrusion into sensitive environmental or protected areas <ul style="list-style-type: none"> ◦ Note: Additional training and certification may be required for personnel entering the area, as well as surveillance by qualified environmental auditors • Improper documentation of ground conditions which will impact pipe protection • Improper marking of crossing points
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Perform QA/QC of survey results by performing audits • Review records of crossings and sensitive environmental or protected areas • Review, confirm, and document population density, inhabitable structure locations, and "identified sites" information for HCA designation • Consistent documentation procedures/forms for inspections and verifications
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Training in proper surveying procedures • Ability to read and interpret construction drawings • Understanding of the elements influencing HCA designations • Ability to identify potential hazards or unexpected ROW conditions
Inspection Requirements	<ul style="list-style-type: none"> • Verification of survey staking (accompanying survey crew) according to construction drawing • Verification of ROW conditions
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Training in proper surveying procedures • Ability to read and interpret construction drawings
Records Requirements	<ul style="list-style-type: none"> • Daily Inspection Reports • Abnormalities or deviations from drawings, recorded as NCR, to gain approval for route changes

8.8.3.4 Ditching

Ditching is the creation of a trench, or ditch, in the ground where the pipeline will be installed and buried. Ditching is a critical activity for pipeline construction, as the shape affects the stresses on the pipeline, the bottom condition affects the possibility of denting, and the depth dictates the final depth of cover (DOC) of the installed and buried pipeline.

Industry references that are applicable to ditching activities include, but are not limited to:

- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;
- API RP 1102, Steel Pipelines Crossing Railroads and Highways; and
- 29 CFR 1926 Subpart P, Excavations.

The potential quality concerns and options for quality control measures for ditching are contained in Table 8.8.3.4-1, below. Additionally, Table 8.8.3.4-1 shows the required training/competency of personnel performing ditching, as well as the inspection and records requirements.

Table 8.8.3.4-1 Minimum Considerations for Development of Ditching Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none">• Ditch profile not in compliance with company specification or pipeline map<ul style="list-style-type: none">◦ Depth and/or width incorrect◦ Points of inflection out of alignment◦ Undulating or rocky ditch bottom• Spoil pile improperly placed or layers improperly segregated• Equipment unsuited for terrain or soil condition• Flooding of ditch
QA/QC and Mitigation Options	<ul style="list-style-type: none">• Contractor selection process used to select appropriate, competent contractor• Audit of contractor responsible for ditching which would include inspection of equipment and procedures• Review of expectations and route with ditching contractor• Verify ditch location as it is created• Consistent documentation procedures/ forms for inspections and verifications
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none">• Able to operate ditching equipment• Experience with ditching activities• Knowledge of company specifications and procedures• Competence and licensure in alternative ditching methods, if applicable, such as ditch blasting
Inspection Requirements	<ul style="list-style-type: none">• Verification of ditch location with regards to marked route• Verification of ditch profile (depth, width, points of inflection, and bottom condition)
Training/Competency of Inspection Personnel	<ul style="list-style-type: none">• Understanding of company specifications• Ability to take required measurements
Records Requirements	<ul style="list-style-type: none">• Daily Inspection Reports• Abnormalities or deviations from specifications, recorded as NCR, to be addressed prior to pipe lowering-in activities

8.8.3.5 Stringing

Stringing is the alignment of line pipe and bends along the ditch according to the pipeline design plan in preparation for welding and installation. Each pipe and component number should be reviewed to verify that the joints are strung in the correct order and that no damage has been sustained. The stringing activities and field bending activities (described in Section 8.8.3.6, below) should be coordinated, so the field-bent pipe locations and bend angles are verified.

Industry references that are applicable to stringing, and post-stringing inspection activities include, but are not limited to:

- *ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries; and*
- *ASME B31.8, Gas Transmission and Distribution Piping Systems.*

The potential quality concerns and options for quality control measures for stringing are contained in Table 8.8.3.5-1, below. Additionally, Table 8.8.3.5-1 shows the required training/competency of personnel performing stringing, as well as the inspection and records requirements.

Table 8.8.3.5-1 Minimum Considerations for Development of Stringing Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Pipe not properly supported and/or secured beside the ditch • Pipe damaged during stringing (denting, gouging, bevel or coating damage, etc.) • Damage is improperly repaired • Pipe not strung in the correct location (class location, HCA, etc.) <ul style="list-style-type: none"> ◦ Wrong grade and/or wall thickness pipe placed ◦ Pre-bent pipe not in the proper location • Insufficient documentation to maintain traceability
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Stringing procedure in place and known to relevant personnel <ul style="list-style-type: none"> ◦ Information on how to address difficult terrain ◦ Information on proper pipe supports ◦ Proper equipment to move pipe without damaging coating • Positive identification procedure for strung pipe <ul style="list-style-type: none"> ◦ Induction bends/elbows at correct location ◦ Pipe grade, wall thickness, etc. at correct location • Consistent documentation procedures/forms for inspections and verifications • Quarantine plan for damaged or improper materials • Repair procedures are documented
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of company stringing procedures and material location plan • Ability to operate equipment used to move and support pipe • Understanding of pipe support procedures • Understanding of repair procedures and limitations
Inspection Requirements	<ul style="list-style-type: none"> • Inspection of lifting equipment to minimize the likelihood of pipe and coating damage • Verification of material location • Inspection of materials for damage and inspection of on-site repairs to damaged areas • Verification that stringing and pipe support are performed per the project specification • Confirmation that traceability is maintained
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company stringing procedures and material location plan • Understanding of proper equipment for moving coated pipe • Understanding of pipe support procedures • Ability to verify correct placement of materials • Ability to identify and measure material damage and compare to the applicable acceptance criteria • Ability to assess the acceptability of repairs
Records Requirements	<ul style="list-style-type: none"> • Daily inspection report • Damaged or incorrect materials recorded as NCR, to be addressed by quarantine plan or repaired per accepted repair procedures • Records sufficient to maintain traceability

8.8.3.6 Field Bending

Field bending is the cold bending of line pipe on the ROW to conform to the planned points of inflection in the pipe route and match the topography or the route/ditch. The field bending activities and stringing activities (described in Section 8.8.3.5, above) should be coordinated, so the field-bent pipe locations and bend angles are verified.

Industry standards that are applicable to field bending include, but are not limited to,

- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries; and*
- ASME B31.8, Gas Transmission and Distribution Piping Systems.*

Wrinkle bends are currently considered an exception to industry best practice. While wrinkle bends or miter bends may comply with the applicable regulations and standards for some operating conditions and design criteria, operating companies should consider the technical disadvantages and limitations of wrinkle bends and miter bends compared to smooth field bends or manufactured bends when developing project specifications. In some cases, field bends may have some technical advantages over manufactured bends since manufactured bends may result in a thickness mismatch and related fit-up challenges.

The potential quality concerns and options for quality control measures for field bending are contained in Table 8.8.3.6-1, below. Additionally, Table 8.8.3.6-1 shows the required training/competency of personnel performing field bending, as well as the inspection and records requirements.

Table 8.8.3.6-1 Minimum Considerations for Development of Field Bending Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Damage to bend <ul style="list-style-type: none"> ◦ Buckling, cracks, wrinkles or any other mechanical damage that exceeds the project specifications ◦ Ovality ◦ Coating damage (Note: abrasive resistant overlay, ARO, is less flexible than fusion bonded epoxy, FBE) ◦ Internal defects caused by bending mandrel ◦ Over strain of pipe or seam weld • Incorrect bend angle achieved • Weld misalignment due to ovality or end deformations • Bend misalignment during installation (e.g., bend rotated) • Insufficient documentation to maintain traceability
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Bending procedure in place and known to relevant personnel <ul style="list-style-type: none"> ◦ Longitudinal seam placement requirements, if applicable • Procedures for visual and instrumented inspection of produced bends <ul style="list-style-type: none"> ◦ Mechanical damage (buckling, cracks, wrinkles, etc.) ◦ Coating damage ◦ Bend angle • Consistent documentation procedures/forms for inspections and verifications • Quarantine plan for bends deemed to be unfit for service
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of company bending procedures • Ability to operate field bending equipment • Knowledge of the bending limits of the project pipe (i.e., wall thickness, grade, and diameter effects)
Inspection Requirements	<ul style="list-style-type: none"> • Visual inspection (internal and external) for damage to the steel or coating material • Verification of the target bend angle • Dimensional verification <ul style="list-style-type: none"> ◦ Bend angle achieved ◦ Ovality in the area of the bend and joint ends affected by bending • Non-destructive testing (NDT) if deformation affects girth weld (e.g., double jointed pipe) • Confirmation that traceability is maintained
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company bending procedures • Ability to identify and measure material damage and deformations and compare with the applicable acceptance standard
Records Requirements	<ul style="list-style-type: none"> • Bend inspection reports <ul style="list-style-type: none"> ◦ Pipe information (joint, heat, diameter, wall thickness, etc.) ◦ Bend angle (planned and achieved) ◦ Relative location of start and stop of bend along joint ◦ Relative location of placement of bend among strung joints ◦ Nonconformities of finished bend, with associated disposition • Damaged bends recorded as NCR, to be addressed by quarantine plan • Records sufficient to maintain traceability

8.8.3.7 Fusion Processes

The fusion of pipe and components is achieved using welding or joining, for metal and plastic components, respectively. Joint configurations include butt or girth welds, branch welds, fillet welds, and socket welds. The welding/joining and non-destructive testing (NDT) activities (described in Section 8.8.3.8, below) should be coordinated. It is essential that defects identified through NDT are communicated to the welding and joining personnel to address quality issues and prevent further defects. For regulated pipelines, the requirements for welding and joining of materials are addressed in 49 CFR 192 Subparts E and F, as well as 49 CFR 195 Subpart D.

8.8.3.7.1 Welding

Welding on the ROW is typically performed using manual shielded-metal arc welding (SMAW) or semi-automatic/mechanized processes such as gas-metal arc welding (GMAW) or flux-cored arc welding (FCAW).

A plan should be put into place to control the qualification and/or use of welding procedures for the project in terms of the version and applicability of a WPS (e.g. the essential variables). Likewise, the welder qualifications and the welding procedures they are qualified to use must be controlled and monitored.

A matrix that covers all welding procedures that will be used for the project (small or large) should be developed that lists the essential variable range for each WPS. From the WPS matrix, a plan for qualifying welders can be developed to better manage the required qualifications. Once a welder is qualified, a matrix should be produced that indicates all the welding procedures the welder can use for the project. The welder should be provided and acknowledge receipt of all the WPSs qualified for project use. It is important that the welder reviews the WPSs to enable proper understanding of the limitations and requirements for the welds to be performed.

For large projects, consideration should be given to activities aimed at the prevention or limitation of start-up issues. Often welding procedure and welder issues can be identified by qualifying on project pipe, preferably the largest diameter and thickest wall. Welding small diameter pipe can also be challenging and therefore should be considered during welder and welding procedure testing. This should be considered best practice for large projects. Welding procedures and welders should be qualified well ahead of construction to identify potential issues. During project start-up, the weld crews should fully complete a set number of welds and detailed NDT should be performed. Any defects and significant indications found during NDT should be communicated to the welders. This allows for issues to be corrected before a large number welds require repair or removal.

Additionally, prior to the start of the project, the acceptable reject rate should be determined by the owner company and welding contractor. A remediation plan should be developed if the reject rate is exceeded.

Industry standards that are applicable to welding include, but are not limited to:

- API 1104, Welding of Pipelines and Related Facilities;
- ASME Boiler and Pressure Vessel Code (BPVC), Section IX, Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators;
- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries; and
- ASME B31.8, Gas Transmission and Distribution Piping Systems.

The potential quality concerns and options for quality control measures for welding are contained in Table 8.8.3.7-1, below. Additionally, Table 8.8.3.7-1 shows the required training/competency of personnel performing welding, as well as the inspection and records requirements.

Table 8.8.3.7-1 Minimum Considerations for Development of Welding Procedures and Quality Plan

<p>Potential Quality Concerns</p>	<ul style="list-style-type: none"> • Improper welding procedure specification (WPS), for example not using a WPS intended for and qualified for weld repair • Improperly qualified or unqualified welder or welding operator, or the WPS requirements are outside of the limits of the welder or welding operator's qualifications • Defective welding equipment or machinery • Improper grounding of the pipe during welding • Improper consumable selection, storage, and use • Improper shielding gas storage or shielding gas contamination • Excessive joint misalignment • Improper bevel dimensions or cleanliness • Weather-related concerns (rain, wind, humidity, cold temperatures, etc.) • Not in compliance with approved WPS <ul style="list-style-type: none"> ◦ Inadequate preheat or improper interpass temperature (preheat applied too early) ◦ Excessive time between root pass and hot pass ◦ Improper heat input or welding outside parameters of WPS (i.e. current, voltage, or travel speed) ◦ Improper joint design or failure to meet specified dimensions ◦ Improper or inadequate cleaning between passes ◦ Improper weld bead placement, weave limit, or stop/start locations ◦ Early release of lineup clamp ◦ Improper size or type of consumables used ◦ Improper shielding gas composition or flow rate utilized • Weld defects, including workmanship flaws and dimensions of finished welds • Copper contamination of welds due to copper backing plates or other sources of copper • Special concerns <ul style="list-style-type: none"> ◦ Cold weather welding ◦ Repair welds ◦ Backwelding ◦ Welds between line pipe and bends or fittings ◦ Wall thickness transitions ◦ Residual magnetism in the pipe • Misapplication of requirements for specific design criteria <ul style="list-style-type: none"> ◦ Weld metal yield strength for strain based design applications ◦ Weld hardness for sour service applications ◦ Weld and HAZ toughness for applications with toughness criteria • Lifting or other movement of the pipe string before weld is completed
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Table 8.8.3.7-1 Minimum Considerations for Development of Welding Procedures and Quality Plan (continued)

QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Proper selection or development for the WPS(s) for the construction project <ul style="list-style-type: none"> ◦ For pipe grades with a specified minimum yield strength (SMYS) greater than or equal to API 5L X70 the WPS should be qualified using project pipe with highest CE or a CE in the highest quartile of the project pipe purchased ◦ Consideration should be given to WPS qualification using project pipe under worse case conditions (i.e. pipe and components with highest CE, low or no preheat, intentional time delay between passes, full joints of pipe welded to a fitting, etc.) ◦ When back welding is permitted the WPS should be qualified both with and without a back weld ◦ Qualification of repair welding procedures to the requirements of Section 10 of the 21st edition of API 1104, Repair and Removal of Weld Defects. Companies that use ASME Section IX based procedures should supplement ASME Section IX qualifications tests with the additional test requirements of API 1104 Section 10 when developing and testing weld repair procedures or take other appropriate measures to demonstrate appropriateness of a WPS for repair. • Consistent documentation procedures/forms for inspections and verifications
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Table 8.8.3.7-1 Minimum Considerations for Development of Welding Procedures and Quality Plan (continued)

QA/QC and Mitigation Options (continued)	<ul style="list-style-type: none"> • Written procedures and training plans for aspects of welding that are not covered in the project WPS(s) <ul style="list-style-type: none"> ◦ Specification for consumable purchase ◦ Quality control plan for consumable receipt, storage, and usage ◦ Quality control plan for shielding gas receipt, storage, and usage ◦ Quarantine plan for consumables that are unfit for welding or not as specified by the WPS ◦ Procedure for re-bevel of cut ends of pipe or fittings ◦ Procedure for misalignment distribution during fit-up, with clear limits on maximum misalignment (high-low) ◦ Procedure to address welding two different wall thicknesses, including joint design and required transition beveling ◦ Procedure provided to welding crew on lineup clamp removal and potential quality issues ◦ Plan to prevent hydrogen cracking with consideration given to time delay before final inspection, if required ◦ Procedures and limitations relevant to inspections performed before a weld is completed (e.g., root pass visual inspection procedures) ◦ Use of supplemental preheat or postweld heating in addition to the requirements of the qualified WPS when hydrogen cracking is a concern ◦ Procedure for tracking welder/welding crew identification, NDT inspection crew identification, etc. for each weld • Appropriate additional WPS testing requirements, as applicable <ul style="list-style-type: none"> ◦ Weld metal yield strength testing for strain based design ◦ Hardness testing for sour service applications, or other applications with a maximum hardness limit ◦ Charpy impact, crack tip opening displacement (CTOD) testing, or other toughness testing for applications with toughness criteria • Periodic review of inspection results to identify patterns or trends in identified weld defects or deficiencies <ul style="list-style-type: none"> ◦ Root cause analyses, as necessary • Communication plan to disseminate findings to welders and inspectors
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Table 8.8.3.7-1 Minimum Considerations for Development of Welding Procedures and Quality Plan (continued)

<p><i>Training/Competency of Personnel Performing Activities</i></p>	<ul style="list-style-type: none"> • Knowledge of the requirements of the project WPS and any unique project requirements • Ability to use relevant inspection instruments and gauges • Understanding of welding and cleaning procedures, visual inspection requirements, proper consumable handling and storage, repair process, fit-up requirements, lineup clamp removal, and preheat requirements • All welders and/or welding operators should be qualified in accordance with Section 6 or 12 of API 1104, Qualification of Welders, or ASME BPVC Section IX. Limitations to the welder's qualifications should be documented and understood • The welder continuity should be maintained according to the requirements of 49 CFR 192.227 and 192.228 and 49 CFR 195.222
<p><i>Inspection Requirements</i></p>	<ul style="list-style-type: none"> • Visual inspection of weld bevel and joint fit-up by the welder • Audit of welding parameters and WPS requirements by the inspector (per the frequency required) <ul style="list-style-type: none"> ◦ Visual inspection of weld bevel and joint fit-up ◦ Welding consumables ◦ Shielding gas and flow rates ◦ Preheat temperature and maintenance ◦ Welding parameters (amperage, voltage, travel speed, heat input, etc.) ◦ Lineup clamp removal (with relation to root and hot pass completion) ◦ Minimum number of weld beads required ◦ Weave limits or bead placement, as applicable ◦ Time between passes • Cleaning/grinding between passes • Visual inspection of completed weld
<p><i>Training/Competency of Inspection Personnel</i></p>	<ul style="list-style-type: none"> • Ability to measure welding parameters, including voltage, current, travel speed, and in some cases heat input • Ability to check compliance with project WPS (consumables, time between passes, welding parameters, etc.) • Understanding of the proper application and maintenance of preheat • Understanding of the proper removal of lineup clamps • Understanding of Section 9 or Annex A of API 1104, Acceptance Standards for NDT, including visual inspection, as applicable • Understanding of proper methods to achieve fit-up (e.g. no hinge welding) • Requirements for % of welds to be audited • Experienced in supervision of weld repair practices

Table 8.8.3.7-1 Minimum Considerations for Development of Welding Procedures and Quality Plan (continued)

Records Requirements	<ul style="list-style-type: none"> • Welders' and/or welding operators' most recent full qualification and all subsequent 6-month continuity NDT reports (i.e. welder continuity log) • Welding inspector audit checklists during welding (of welding parameters and WPS requirements) linked to the weld number audited • Weld inspection reports <ul style="list-style-type: none"> ◦ Pipe information (joint, heat, diameter, wall thickness, etc.) ◦ Welder(s) or welding operator(s) ◦ Inspection crew ◦ Nonconformities of finished weld, with associated disposition • Weld repair reports (as applicable) <ul style="list-style-type: none"> ◦ Pipe information (joint, heat, diameter, wall thickness, etc.) ◦ Original weld number and defect ◦ NDT method utilized to detect defect ◦ Repair location and length ◦ Welder(s) or welding operator(s) ◦ Inspection crew ◦ Nonconformities of finished weld, with associated disposition • Any anomalies that were deemed acceptable and that may appear on future ILI runs should be well documented and brought to the attention of as-built project team and operation group.
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8.8.3.7.2 Joining of Plastic Pipe

Joining is described as the heat fusion or electrofusion of plastic pipe and components.

Industry standards that are applicable to plastic joining include, but are not limited to:

- ASME Boiler and Pressure Vessel Code (BPVC), Section IX, Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators;
- ASME B31.8, Gas Transmission and Distribution Piping Systems;
- ASTM D2513, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings;
- ASTM F1055, Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing;
- ASTM F2620, Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings; and
- PPI TR-33, Generic Butt Fusion Joining for Polyethylene Gas Pipe.

The potential quality concerns and options for quality control measures for plastic joining are contained in Table 8.8.3.7-2, below. Additionally, Table 8.8.3.7-2 shows the required training/competency of personnel performing joining, as well as the inspection and records requirements.

Table 8.8.3.7-2 Minimum Considerations for Development of Plastic Joining Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none">• Improper joining procedure for plastic components• Improperly qualified or trained personnel performing plastic joining activities• Defective or improper joining equipment, or contaminated surfaces of plastics heating plates• Excessive joint misalignment• Improper end face dimensions or cleanliness• Weather-related concerns (rain, wind, humidity, cold temperatures, etc.)• Not following approved plastic joining procedure<ul style="list-style-type: none">◦ Inadequate end face preparation◦ Inadequate heating temperature◦ Improper force applied to components◦ Inadequate hold times• Defective or contaminated plastic joints• Special concerns<ul style="list-style-type: none">◦ Cold weather joining◦ joining between plastic pipe and plastic components or fittings
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Table 8.8.3.7-2 Minimum Considerations for Development of Plastic Joining Procedures and Quality Plan (continued)

QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Proper joining process(es) developed and documented for plastic components, including required equipment, cleaning or surface preparation procedures, facing requirements, alignment requirements, heating temperatures/times (including initial heating and heat soak), required force(s) and hold times, cooling requirements, etc. • Use of a data-logging device for hydraulic or electrofusion joining equipment to verify critical fusion parameters are met for each joint • Destructive testing of plastic joints on a sample basis, as applicable • Consistent documentation procedures/forms for inspections and verifications • Written procedures and training plans for aspects of joining that are not covered in the project plastic joining procedures <ul style="list-style-type: none"> ◦ Quarantine plan for pipe or components that are unfit for joining ◦ Procedure for re-facing cut ends of pipe or fittings ◦ Procedure for misalignment distribution during fit-up, with clear limits on maximum misalignment (high-low) ◦ Procedure provided to joining crew on lineup clamp use and removal, as applicable ◦ Procedure for recording joining personnel identification, inspection number, etc., as applicable • Periodic review of inspection results to identify patterns or trends in identified joint defects or deficiencies <ul style="list-style-type: none"> ◦ Root cause analyses, as necessary ◦ Communication plan to disseminate findings to joining personnel and inspectors • Quarantine plan for defective or contaminated components, including electrofusion components with damaged protective wrappings
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Knowledge of the requirements of the project plastic joining procedure(s) • Ability to use relevant inspection instruments and gauges • Understanding of joining and cleaning procedures, visual inspection requirements, fit-up requirements, lineup clamp removal, etc. • All personnel performing plastics joining activities should be qualified and remain qualified according to the requirements in 49 CFR 192.285

Table 8.8.3.7-2 Minimum Considerations for Development of Plastic Joining Procedures and Quality Plan (continued)

<p><i>Inspection Requirements</i></p>	<ul style="list-style-type: none"> • Visual inspection of plastic component end faces prior to joining • Audit of plastic joining parameters and procedure requirements by the inspector (per the frequency required by the welding process). Note: data-logging may be performed, however, this does not replace the need for visual inspection. <ul style="list-style-type: none"> ◦ Visual inspection of plastic pipe and fitting end faces and joint fit-up ◦ Heating plate surface conditions ◦ Heating times/temperatures (initial, soak, etc.) ◦ Required forces/pressures and hold times ◦ Cooling requirements • Visual inspection of melt pattern for plastic joining applications • Destructive testing of plastic joints on a sample basis, as applicable
<p><i>Training/Competency of Inspection Personnel</i></p>	<ul style="list-style-type: none"> • Ability to confirm plastic joining parameters, including temperatures, forces/pressures, and time requirements for each stage (initial heat, soaking, fusion, and cooling) • Ability to visually inspect plastic joints according to the requirements of the joining procedure
<p><i>Records Requirements</i></p>	<ul style="list-style-type: none"> • Plastic joining personnel's most recent full qualification • Plastic joining inspector audit checklists during welding (pre-joining visual inspection and procedure parameters) linked to the joint number audited • Plastic joining inspector reports <ul style="list-style-type: none"> ◦ Plastic pipe information ◦ Joining personnel ◦ Inspection crew information ◦ Nonconformities of finished joint, with associated disposition

8.8.3.8 Non-Destructive Testing (NDT) of Welds

Non-destructive testing (NDT) of welds is performed to detect weld flaws that could adversely affect the integrity of the weld in service. NDT supplements visual inspection conducted by welding inspectors, welders, or contracted inspection staff, which is addressed in Section 8.8.3.7.1, Welding. The NDT and welding activities should be coordinated; it is essential that weld defects identified through NDT are communicated to the welding crews to address quality issues and prevent further defects.

Effective NDT methods are optimized based on the type and size of weld flaws that are integrity concerns. The type and size of weld indications that are deemed "defects" are determined using either the workmanship criteria specified in Section 9, Acceptance Standards for NDT, of API 1104 or through a service-specific fitness for service assessment per the requirements of Annex A, Alternative Acceptance Standards for Girth Welds, of API 1104. Once the rejectable flaws sizes have been defined, NDT procedures should be developed, documented, and demonstrated to show that the combination of inspection technology, procedure, and qualified inspector is capable of detecting the range of flaws of interest. During construction, the NDT process should be controlled so the approved procedure is followed, the inspection results are properly documented, and the inspection personnel are properly trained and qualified.

A best practice for auditing NDT activities is to have an independent review performed by someone who did not perform the inspection. That review can be performed by a Level II or Level III NDT contractor or operating company representative who did not perform the original inspection or a 3rd party auditor who is experienced with the NDT method used. The results of the audit(s) should be documented and used to determine if further or increased review of NDT inspection results is warranted and if any additional training or changes to the NDT procedure is necessary.

Industry standards that are applicable to NDT include, but are not limited to the following:

- *API 1104, Welding of Pipelines and Related Facilities;*
- *ASME Boiler and Pressure Vessel Code (BPVC), Section IX, Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; and*
- *ASNT SNT-TC-1A, Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing.*

For pipelines built to the requirements of 49 CFR Part 192 or Part 195, the minimum percentages of welds inspected using NDT should comply with the requirements in 49 CFR 192.243(d) or 49 CFR 195.234, as applicable. It should be noted, that at the time of this report, 49 CFR 192.241(c) and 49 CFR 195.228(b) allow the acceptability of a weld to be determined using only API 1104 Section 9, Acceptance Standards for NDT, or API 1104 Annex A, Alternative Acceptance Standards for Girth Welds.

The potential quality concerns and options for quality control measures for NDT are contained in Table 8.8.3.8-1, below. Additionally, Table 8.8.3.8-1 shows the required training/competency of personnel performing NDT, as well as the inspection and records requirements.

Table 8.8.3.8-1 Minimum Considerations for Development of NDT Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none">• Failure to detect rejectable defects, due to:<ul style="list-style-type: none">◦ Selection and application of an inspection method or inspection equipment that is not suitable for detection of the flaws of interest (e.g., using magnetic particle inspection equipment to detect embedded flaws, or using the incorrect transducer or wedge angle for shear wave UT inspection)◦ Improper setup and calibration of NDT equipment◦ Inadequate inspection resolution and quality requirements caused, for example, by improper development of radiographic film• Acceptance of rejectable defects, due to:<ul style="list-style-type: none">◦ Improper interpretation of detectable indications◦ Incomplete understanding of the acceptance criteria• Incomplete communication of NDT results to the welders, which can prevent effective mitigation of conditions contributing to the generation of defects <p><i>Note: Personnel safety issues related to radiographic inspection should also be considered</i></p>
QA/QC and Mitigation Options	<ul style="list-style-type: none">• Verification and documentation of NDT personnel qualifications• Written NDT procedures approved by ACCP/ASNT Level III in place and known to relevant personnel<ul style="list-style-type: none">◦ Optimized for the joint configurations and integrity threats applicable to the project◦ Documented verification that the NDT procedure produces the required sensitivity to detect anomalous conditions• Applicable staff trained to recognize conditions that result in a higher than normal risk (increased likelihood or increased consequence of failure)<ul style="list-style-type: none">◦ Documented process for identification of conditions that may warrant supplemental inspection or testing beyond code requirements (e.g., high axial strains, welds near environmentally sensitive areas, etc.)• Reexamination of a certain percentage of inspection records by a third party or operating company representative, as applicable. Consideration should be given to increasing the percentage of records reviewed if discrepancies are found between the record of the initial inspection and the results of the reexamination
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none">• Understanding of project NDT procedures• Understanding of Section 9 of API 1104, Acceptance Standards for NDT, including visual inspection• Understanding of Annex A of API 1104, Alternative Acceptance Standards for Girth Welds, as applicable• ASNT SNT-TC-1A Level I, II, or III as required (only a Level II or Level III may interpret NDT results and determine acceptance of a weld)

Table 8.8.3.8-1 Minimum Considerations for Development of NDT Procedures and Quality Plan (continued)

<p><i>Inspection Requirements</i></p>	<ul style="list-style-type: none"> • <i>Inspection per the requirements of API 1104, Section 9, Acceptance Standards for NDT or API 1104, Annex A, Alternative Acceptance Standards for Girth Welds, including:</i> <ul style="list-style-type: none"> ◦ <i>Visual inspection of all completed weld</i> ◦ <i>Volumetric inspection by radiography or ultrasonic testing for butt or groove welds</i> ◦ <i>Magnetic particle inspection or dye penetrant inspection of fillet welds and branch groove welds</i> • <i>Supplemental inspections or multiple reviews, as required by project specifications</i>
<p><i>Training/Competency of Inspection Personnel</i></p>	<ul style="list-style-type: none"> • <i>Understanding of project NDT procedures</i> • <i>Understanding of Section 9 of API 1104, Acceptance Standards for NDT, including visual inspection</i> • <i>Understanding of Annex A of API 1104, Alternative Acceptance Standards for Girth Welds, as applicable</i> • <i>ASNT SNT-TC-1A Level I, II, or III as required</i> • <i>Auditors properly trained to recognize deviations from established procedures</i>
<p><i>Records Requirements</i></p>	<ul style="list-style-type: none"> • <i>NDT personnel qualifications</i> • <i>NDT procedures</i> • <i>Weld inspection reports</i> <ul style="list-style-type: none"> ◦ <i>Pipe information (joint, heat, diameter, wall thickness, etc.)</i> ◦ <i>Welder(s) or welding operator(s)</i> ◦ <i>Inspection crew</i> ◦ <i>Nonconformities of finished weld, with associated disposition</i> • <i>Weld repair reports (as applicable)</i> <ul style="list-style-type: none"> ◦ <i>Pipe information (joint, heat, diameter, wall thickness, etc.)</i> ◦ <i>Original weld number and defect</i> ◦ <i>NDT method utilized to detect defect</i> ◦ <i>Repair location and length</i> ◦ <i>Welder(s) or welding operator(s)</i> ◦ <i>Inspection crew</i> ◦ <i>Nonconformities of finished weld, with associated disposition</i> • <i>Any anomalies that were deemed acceptable and that may appear on future ILI runs should be well documented and brought to the attention of as-built project team and operations group.</i>

8.8.3.9 Field Coating

The majority of field coating activities include girth weld coating. Girth welds are coated after welding is complete and any NDT is performed and therefore may not receive the same level of factory quality coating as the pipe body. Often referred to as field joint coating, examples include: fusion bonded epoxy (FBE), two part epoxy, tape wrap, and shrink sleeves. The field coating is applied before the pipe is installed into the ditch, except at tie-in locations. Proper application and inspection of field coating is critical to prevent localized corrosion at the girth weld or other field coating locations.

Industry standards that are applicable to field coating include, but are not limited to:

- *NACE RP0105, Standard Recommended Practice – Liquid-Epoxy Coatings for External Repair, Rehabilitation, and Weld Joints on Buried Steel Pipelines;*
- *NACE RP0303, Standard Recommended Practice – Field-Applied Heat-Shrinkable Sleeves for Pipelines: Application, Performance, and Quality Control;*
- *NACE RP0402, Standard Recommended Practice – Field-Applied Fusion-Bonded Epoxy (FBE) Pipe Coating Systems for Girth Weld Joints: Application, Performance, and Quality Control;*
- *NACE RP0602, Standard Recommended Practice – Field-Applied Coal Tar Enamel Pipe Coating Systems: Application, Performance, and Quality Control;*
- *NACE No. 1/SSPC-SP 5, Joint Surface Preparation Standard – White Metal Blast Cleaning;*
- *NACE No. 2/SSPC-SP 10, Joint Surface Preparation Standard – Near-White Metal Blast Cleaning;*
- *SSPC-SP 3, Power Tool Cleaning;*
- *DNV-RP-F102, Pipeline Field Joint Coating and Field Repair of Linepipe Coating – DNV Recommended Practice;*
- *ISO 21809-3, Petroleum and Natural Gas Industries – External Coatings for Buried or Submerged Pipelines used in Pipeline Transportation Systems – Part 3: Field Joint Coatings; and*
- *NS-EN 10329, Steel Tubes and Fittings for Onshore and Offshore Pipelines – External Field Joint Coatings*

The potential quality concerns and options for quality control measures for field coating are contained in Table 8.8.3.9-1, below. Additionally, Table 8.8.3.9-1 shows the required training/competency of personnel performing field coating, as well as the inspection and records requirements.

Table 8.8.3.9-1 Minimum Considerations for Development of Field Coating Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none">• <i>Selection of the wrong coating system for the operating environment (such as immersion service, hot or cold service, UV exposure, cathodic protection, etc.)</i>• <i>Compatibility issues with the adjacent factory-applied coatings</i>• <i>Improper surface preparation and cleanliness</i><ul style="list-style-type: none">◦ <i>Anchor pattern or profile</i>◦ <i>Removal of surface oxides and contamination consistent with the surface quality level required for the selected coating</i>◦ <i>Weld spatter causing surface irregularities</i>◦ <i>Moisture on pipe</i>• <i>Improper coating application, including, but not limited to:</i><ul style="list-style-type: none">◦ <i>Improper mixing of components</i>◦ <i>Use of improper thinner</i>◦ <i>Coating induction time or cure time not followed</i>◦ <i>Improper heating or application temperature</i>◦ <i>Inadequate or excessive coating thickness</i>• <i>Steel not properly coated around entire circumference</i>• <i>Improper coating storage</i>• <i>Improper curing of coating, including movement or backfilling of the pipe before the coating has completely cured</i>• <i>Cracked coating from pipe movement or lifting and lowering</i>
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Table 8.8.3.9-1 Minimum Considerations for Development of Field Coating Procedures and Quality Plan (continued)

QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Verification and documentation of service conditions and coating service limits • Verification of compatibility with adjacent factory-applied coating • Verification and documentation of coating personnel qualifications • Consistent documentation procedures/forms for inspections and verifications • Coating procedures and quality plan in place and known to relevant personnel, which addresses: <ul style="list-style-type: none"> ◦ anchor pattern of pipe ◦ surface cleanliness and chlorides of pipe ◦ surface preparation and overlap of adjacent factory-applied coatings ◦ proper mixing of multi-component coatings ◦ proper application method/equipment ◦ application temperature control ◦ coating storage ◦ humidity ◦ adhesion ◦ moisture permeation ◦ bending ◦ coating thickness ◦ holiday detection ◦ repair • Visually inspect coating after installation in the ditch (in addition to above inspections for thickness, holidays, etc. as applicable)
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Current, company-approved training and qualification to prepare and apply coating • Trained to follow project/company specific field coating procedure (including proper surface preparation methods) • Training in proper use of application equipment

Table 8.8.3.9-1 Minimum Considerations for Development of Field Coating Procedures and Quality Plan (continued)

<p><i>Inspection Requirements</i></p>	<ul style="list-style-type: none"> • <i>Observe and document that company/job procedures are followed at a defined frequency</i> • <i>Verification that product meets project specification</i> • <i>Verification of surface preparation and cleanliness, including the exposed steel and the adjacent coating</i> • <i>In the case of shrink sleeves or other hot-applied products, comparison of actual to specified application temperatures</i> • <i>Verification that field coatings and repairs extend the recommended distance over adjacent coatings</i> • <i>In the case of tape wrap coatings, verification of tape overlap, i.e., spiral angle, and absence of wrinkles</i> • <i>In the case of liquid-applied coatings, confirmation of dry film thickness or other specified thickness-related measurement, and absence of runs, drips, and inclusions</i> • <i>Holiday detection test for liquid-applied coatings</i> • <i>Visual inspection for cracking, delamination, blistering, or other signs of improper application</i>
<p><i>Training/Competency of Inspection Personnel</i></p>	<ul style="list-style-type: none"> • <i>Personnel inspecting coating must exhibit the knowledge, skills and ability to verify effective coating application</i> • <i>NACE Certified Coating Inspector - Level 3, or other, as required</i>
<p><i>Records Requirements</i></p>	<ul style="list-style-type: none"> • <i>Documentation of coating type, manufacturer, lot numbers</i> • <i>Surface preparation specification and verification</i> • <i>Coating inspection reports</i>

8.8.3.10 Coating Holiday Inspection (Jeeping) and Coating Repairs

The information contained in Section 8.8.3.9, Field Coating is applicable to coating repairs, with the addition of concerns listed in this section.

Coating damage can occur during handling, storage, transportation, stringing, bending, welding, lowering-in, and backfilling. Integrity inspection of the pipeline coating(s) for damage is done both visually and by using a holiday detector, a method commonly referred to as "jeeping." Jeeping, which utilizes an inspection device which transmits an electrical current in the pipe, is capable of identifying small areas of coating damage (specifically discontinuities in the coating), or "holidays." It is important that the voltage is properly set for the coating type and thickness to enable an accurate inspection. Once coating damage has been identified, it is critical to repair the damage as the coating helps protect the pipe from external corrosion. The repair method utilized is dependent on the type of coating being repaired. Manufacturers of coatings typically specify repair requirements and procedures that detail how the repair is to be performed. The qualification of individuals performing the jeeping and coating repair should be verified prior to performing the activity.

Typically, jeeping will be performed a minimum of two times during construction: once after field joint coating application and again during lowering-in. During the lowering-in process, coating damage can occur from rocks imbedded in the lifting straps or setting the pipe on rocks/ledges in the ditch. Since another coating inspection is rarely performed after the pipe is lowered into the ditch, coating damage that occurs during the lowering-in process may remain undetected. Therefore it is critical to perform lowering-in procedures very carefully and to perform a thorough visual inspection of accessible surfaces after lowering-in.

Industry standards that are applicable to jeeping and coating repairs include, but are not limited to:

- NACE SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates;
- NACE SP0274, High-Voltage Electrical Inspection of Pipeline Coatings;
- NACE SP0490, Holiday Detection of Fusion-Bonded Epoxy External Pipeline Coatings of 250-760 μm (10 to 30 mil); and
- ASTM D5162, Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.

The potential quality concerns and options for quality control measures for jeeping and coating repairs are contained in Table 8.8.3.10-1, below. Additionally, Table 8.8.3.10-1 shows the required training/competency of personnel performing jeeping and coating repairs, as well as the inspection and records requirements. Note, the information in Table 8.8.3.9-1, above, is also applicable to coating repairs.

Table 8.8.3.10-1 Minimum Considerations for Development of Jeeping and Coating Repair Procedures and Quality Plan (in Addition to those in Table 8.8.3.9-1)

Potential Quality Concerns	<ul style="list-style-type: none"> • Not detecting coating damage, holidays, or pinholes <ul style="list-style-type: none"> ◦ Use of improper detector voltage ◦ Use of improper or inadequate detection equipment ◦ Improper use of detection equipment <ul style="list-style-type: none"> • Detector is not properly grounded • Coil is loose around the pipe • Speed of detector is too high ◦ Detection equipment does not function properly ◦ Areas of pipe not examined ◦ Damage to pipe coating during detection due to excessive voltage settings ◦ Damage to pipe after inspection occurs • Surface preparation and cleanliness for repair coating procedure • Improper application of repair coating • Use of improper repair coating • Coating not bonding to repaired area • Incompatibility of repair coating and mainline coating
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Appropriate holiday detection procedures in place and known to relevant personnel • Verify proper holiday detector voltage for the coating type and coating thickness • Verify that the holiday detector coil is snug around the pipe • Confirm holiday detector is properly grounded • Validate functionality of detector by jeeping bare area of pipe (or area with visually observable defect) • Verify all required areas are inspected • Take precautions to avoid damaging the pipe after inspection
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Personnel trained to project/company specific holiday inspection and coating repair procedures • Personnel trained and knowledgeable to use holiday detection equipment • Personnel trained on proper application of coating repair in accordance with the applicable project procedures and specifications
Inspection Requirements	<ul style="list-style-type: none"> • Verification at a defined frequency that holiday detector equipment is functioning properly and within any required calibration • Verification that product meets project specification • Observe and document that company/project procedures are followed
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Trained on proper use of holiday detection equipment • Personnel inspecting coating must exhibit the knowledge, skills and ability to verify effective coating application • NACE Certified Coating Inspector – Level 3, or other, as required

Table 8.8.3.10-1 Minimum Considerations for Development of Jeeping and Coating Repair Procedures and Quality Plan (in Addition to those in Table 8.8.3.9-1) (continued)

Records Requirements	<ul style="list-style-type: none">• Documentation of repair coating type, manufacturer, lot numbers, etc.• Coating repair inspection reports, including holiday detection equipment traceability and repair locations
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8.8.3.11 Ditch Padding

Ditch padding, when required, is performed prior to lowering-in the pipeline to protect the bottom-side of the pipe where conditions on the ditch bottom (i.e. rocks, rock ledge, and hardpan) can dent the pipe. One method of ditch padding is to "bed" the ditch using non-native materials such as sand, or filtered or non-filtered native materials removed while ditching (spoils). Another method of ditch padding is to support the pipeline on sand bags, foam pillows, or plastic pipe support apparatuses, and allow the backfill materials to flow between the supports. Distance between padding supports influences the amount of pipe settlement that occurs during backfill, hydrostatic testing, and by the product. Too large of spacing between padding supports has been known to cause ovality and dents.

The potential quality concerns and options for quality control measures for ditch padding are contained in Table 8.8.3.11-1, below. Additionally, Table 8.8.3.11-1 shows the required training/competency of personnel performing ditch padding, as well as the inspection and records requirements.

Table 8.8.3.11-1 Minimum Considerations for Development of Ditch Padding Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Denting of pipeline or coating damage due to inadequate bedding <ul style="list-style-type: none"> ◦ Inadequate bedding depth ◦ Hard or rocky bedding material ◦ Washout of bedding prior to lowering-in • Denting of pipeline or coating damage due to inadequate sand-bag or pillow support <ul style="list-style-type: none"> ◦ Inadequate sandbag or foam pillow height ◦ Improper sandbag or foam pillow spacing ◦ Inadequate foam pillow strength (crushing) ◦ Non-compressible sandbags or pillows (denting at supports) ◦ Non-compacted backfill material between sand-bags or pillows
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Design calculations for proper sandbag/pillow spacing and size • Full-scale testing of pillows and sandbags (crush test, dent test, etc.) • Padding machines with appropriate screen size • Appropriate padding procedures in place and known to relevant personnel <ul style="list-style-type: none"> ◦ Bedding procedure (addressing appropriateness of native materials for bedding) ◦ Support placement procedure (sandbags or foam pillows) ◦ Foam pillow spray procedure • Inspection of padding immediately prior to lowering-in
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of company padding procedures, including ability to determine if native materials are appropriate for bedding activities • Appropriate training on foam pillow spraying, as applicable • Ability to operate padding machines
Inspection Requirements	<ul style="list-style-type: none"> • Visual inspection of the bedding materials <ul style="list-style-type: none"> ◦ Appropriate material used (properly filtered, etc.) ◦ Bedding depth • Visual inspection of support materials <ul style="list-style-type: none"> ◦ Sandbag/pillow spacing ◦ Sandbag/pillow size
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company padding procedures • Ability to take required measurements
Records Requirements	<ul style="list-style-type: none"> • Daily inspection report • Improper padding recorded as NCR, to be addressed prior to lowering-in activities • Manufacturing information for commercial padding utilized, as applicable

8.8.3.12 Lifting and Lowering-In

Lifting and lowering-in is the process of moving a pipe string from alongside the ditch into the ditch. This operation is performed using side booms and/or backhoes equipped with special rollers or slings. The operation generally requires the coordination of many pieces of heavy equipment at the same time to safely move the pipe string into place. Care must be taken during this operation to avoid damage to the completed pipe string and over-stressing the girth welds. When API 1104 Annex A alternative acceptance criteria is used for the girth welds, it is critical that lift height (bottom of ditch to bottom of pipe), support spacing and lowering-in procedures are well described and followed. The acceptance criteria is based on the maximum stress that will occur based on lowering conditions and equipment spacing.

There are currently no industry standards that address pipe lifting or lowering-in of a new pipeline.

The potential quality concerns and options for quality control measures for lifting and lowering-in activities are contained in Table 8.8.3.12-1, below. Additionally, Table 8.8.3.12-1 shows the required training/competency of personnel performing lifting and lowering-in activities, as well as the inspection and records requirements.

Table 8.8.3.12-1 Minimum Considerations for Development of Lifting and Lowering-In Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Damage to pipe or pipe coating <ul style="list-style-type: none"> ◦ Inadequate padding or improper support straps ◦ Insufficient clearance over and into ditch ◦ Inadequate number of side booms • Overstrain of pipe and/or girth welds <ul style="list-style-type: none"> ◦ Inadequate number of side booms ◦ Improper spacing between booms ◦ Excessive lift heights • Incorrect placement in the ditch • Coating damage from straps or cradles used during lifting and lowering.
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Modeling of pipe stresses to determine appropriate boom spacing and lift heights • Confirmation of ditch padding prior to lifting • Inspection of side boom spacing and padding prior to lifting • Appropriate lifting and lowering-in procedures in place and known to relevant personnel. The procedures should include: <ul style="list-style-type: none"> ◦ Appropriate lifting straps, padded rollers, or other appropriate protective padding ◦ Required side boom spacing ◦ Maximum allowable lift height • Jeeping of pipe coating before/after lifting and lowering, as applicable • Plan to verify pipe is properly aligned in ditch, and that no external force is utilized to fit the pipe to the ditch • Documented repair procedures for coating and pipe
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of company lifting and lowering procedures (spotters and side boom operators) • Operators qualified for side boom equipment operation • Trained in repair procedures, if responsible for performing repairs
Inspection Requirements	<ul style="list-style-type: none"> • Inspect side boom rollers, pads, and straps • Inspection of ditch bottom prior to lowering in, including required bedding and pillow/sand bag placement • Verify side boom spacing and maximum lift height • Inspection of coating and pipe repairs in accordance with project specifications
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company lifting and lowering-in procedures • Ability to take required measurements • Ability to perform inspections applicable to the types of repairs performed and to judge the acceptability of the repairs based on comparison to project specifications
Records Requirements	<ul style="list-style-type: none"> • Daily inspection report • Improper lifting/lowering-in practices recorded as NCR, to be addressed prior to continuation of lowering-in activities • Documentation of repairs in appropriate format

8.8.3.13 Local Pipe Attachments

8.8.3.13.1 Cathodic Protection (CP) System and Corrosion Monitoring

The cathodic protection (CP) and corrosion monitoring systems should be properly designed, installed, and connected to the pipeline via local pipe attachments.

For impressed current CP systems, the installation of anode ground beds impacts the electrical resistance of the CP system. These anodes should be completely surrounded with well compacted carbonaceous backfill to avoid voids which increase the total electrical resistance of the circuit. Additionally, it is very important to handle the anode cables with care to avoid damaging the electrical insulation; minor damages may result in a rapid cable failure. Underground or submerged cable connections must be sealed to prevent moisture penetration so that electrical isolation from the environment is achieved.

The location of the anode ground beds may generate interference with other metallic structures in close proximity. This condition is normally considered in the design phase; however, conditions may have changed between CP design and system installation. Finally, the pipeline being installed may be susceptible to stray current from other direct current sources such as foreign CP systems, which could have a detrimental effect on the pipeline system integrity.

To connect the CP system and the test stations or survey instruments used to take CP potential or current measurements, local pipe attachments, such as wires or leads, are attached to the pipe surface. The leads can be fused to the pipe by either non-exothermic welding, such as pin brazing, or exothermic welding, such as CADWELD®. Currently there is no explicit requirement to qualify a joining procedure to attach wires to the pipe surface. The information contained in Section 8.8.3.9, Field Coating is applicable to coating the local attachments.

Industry standards that are applicable to CP system design and installation, or qualification of joining procedures to attach leads include, but are not limited to:

- 49 CFR 192 Subpart I, Requirements for Corrosion Control;*
- 49 CFR 195 Subpart H, Corrosion Control;*
- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;*
- ASME B31.8, Gas Transmission and Distribution Piping Systems;*
- BS EN 4515-1, Specification for Welding of Steel Pipeline on Land and Offshore, Part 1: Carbon and Carbon Manganese Steel Pipelines, Annex B, Recommendations for Brazing and Aluminothermic Welding of Anode Bonding Leads;*
- CSA Z662, Oil and Gas Pipeline Systems;*
- ISO 13847, Petroleum and Natural Gas Industries – Pipeline Transportation Systems – Welding of Pipelines, Annex C, Recommendations for Brazing and Aluminothermic Welding of Anode Leads;*
- NACE SP0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems; and*
- NACE SP0572, Design, Installation, Operation, and Maintenance of Impressed Current Deep Anode Beds.*

The potential quality concerns and options for quality control measures for local pipe attachments for CP and corrosion monitoring are contained in Table 8.8.3.13-1, below. Additionally, Table 8.8.3.13-1 shows the required training/competency of personnel performing local pipe attachments for CP and corrosion monitoring, as well as the inspection and records requirements. The information contained in Section 8.8.3.9, Field Coating is applicable to coating the local attachments.

Table 8.8.3.13-1 Minimum Considerations for Development of Local Pipe Attachment Procedures and Quality Plan for CP and Corrosion Monitoring (in Addition to those in Table 8.8.3.9-1)

Potential Quality Concerns	<ul style="list-style-type: none"> • Creation of undesirable microstructures in the pipe at the site of local attachments • Burn-through of thin-wall pipe (<0.150 inches) when using an exothermic welding process • Poor electrical and or mechanical attachment • Detachment of leads during backfilling • Failure to effectively coat the connection • Improper installation of impressed anode ground beds • Installation of CP cables with damaged electrical insulation • Creation of stray current interference due to improper anode ground bed site selection • Reversed electrical connections between the pipeline and rectifier • Condition changes between design and installation leading to insufficient CP
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Establish and properly qualify a written joining procedure for leads, which documents the following: <ul style="list-style-type: none"> ◦ Surface preparation requirements ◦ Minimum wall thickness and maximum carbon equivalent of the pipe at attachment sites ◦ Measurement of attachment site wall thickness ◦ Minimum distances from other welds, adjacent lead attachment or unsuccessful attempts to attach lead ◦ Specification of exothermic charge size range, as applicable • Provide slack and be aware of wire placement to minimize stress on the lead during backfilling • Use an approved coating and coating application procedure • Inspect compaction of carbonaceous backfill around anodes • Visually inspect and test the area where the anode bed will be installed to identify potential buried structures susceptible to stray current. • Perform a CP survey to identify potential stray current after installing the pipeline and the CP system • Verify that the rectifier is properly connected
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Trained on the procedure requirements and use of the joining method • Demonstrated use of joining method • Trained in use of the protective coating procedure • Qualified to perform the exothermic weld task • Qualified to apply coating to exothermic weld • Trained to perform Cathodic protection surveys to identify potential stray current interference

Table 8.8.3.13-1 Minimum Considerations for Development of Local Pipe Attachment Procedures and Quality Plan for CP and Corrosion Monitoring (in Addition to those in Table 8.8.3.9-1) (continued)

<i>Inspection Requirements</i>	<ul style="list-style-type: none"> • Confirmation of electrical continuity • Confirmation of mechanical security of attached lead • Confirmation of field coating at attachment sites
<i>Training/Competency of Inspection Personnel</i>	<ul style="list-style-type: none"> • Understanding of company attachment procedures for CP and corrosion monitoring systems • Ability to take required measurements • Operator Qualified to perform the task, as applicable
<i>Records Requirements</i>	<ul style="list-style-type: none"> • Pipe attachment report, which includes: <ul style="list-style-type: none"> ◦ Precise location of each attachment for correlation with ILI reports ◦ Total number of unsuccessful/successful attempts to attach the lead to the pipe • Coating inspection reports, including documentation of coating type, manufacturer, lot numbers, etc.

8.8.3.13.2 Post-Commissioning Condition Monitoring

Pipeline design and construction are the ideal stages to consider and accommodate any specialized equipment for on-going monitoring of the pipeline condition. Examples include:

- Buried corrosion coupons or corrosion probes to supplement potential test stations for monitoring CP effectiveness, seasonal changes in soil corrosiveness, or for establishing soil corrosion rates for use in determining pipeline reassessment intervals.
- Permanently mounted sensors for monitoring pipe for evidence of wall thickness changes or mechanical damage. Interconnects, branch connections, and bypass piping often cannot be inspected by ILI. Buried sensors can also facilitate non-destructive monitoring of localized areas of buried or inaccessible pipe in between scheduled in-line inspections. One example is the use of guided wave UT transducer arrays for monitoring inaccessible lengths of the piping. The second example is the attachment of electric field mapping sensors to the external surface of a pipe to detect changes in wall thickness caused by internal corrosion at pre-selected locations.
- Fiber optic sensors or strain gauges for monitoring unintended pipe bending strains caused by ground deformation. For example, these may be positioned near fault crossings, on potentially unstable slopes, or in areas subject to subsidence or possible frost heave.

The diversity of the available instrumentation has different effects on construction operations. Some instruments may only affect a very short length (i.e., less than one foot) of pipe, while others may require specialized installation and inspection practices for several hundred feet of piping. Localized coating repairs, much like those associated with installation of CP cables, may be required; the information contained in Section 8.8.3.9, Field Coating, is applicable to coating the local attachments. The backfilling operation must be performed carefully to avoid damage to sensors and the related cables that extend from the instruments to an above-grade location (generally ground-level or pole-mounted utility box where the related wires or cables terminate). The locations of the sensors and the above ground termination of the cables or wires should be carefully recorded. Calibration and/or baseline measurements used for comparison with future measurements should be made to verify proper function of the sensors before they become inaccessible following backfilling.

Industry standards that are applicable to post-commissioning condition monitoring and which potentially influence pipeline construction practices include, but are not limited to:

- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;
- ASME B31.8, Gas Transmission and Distribution Piping Systems;
- NACE RP0497, Field Corrosion Evaluation Using Metallic Test Specimens; and
- NACE RP0104, The Use of Coupons for Cathodic Protection Monitoring Applications.

The potential quality concerns and options for quality control measures for local pipe attachments for post-commissioning condition monitoring are contained in Table 8.8.3.13-2, below. Additionally, Table 8.8.3.13-2 shows the required training/competency of personnel performing local pipe attachments for post-commissioning condition monitoring, as well as the inspection and records requirements. If field coating is required, the information contained in Section 8.8.3.9, Field Coating, is applicable.

Table 8.8.3.13-2 Minimum Considerations for Development of Local Pipe Attachment Procedures and Quality Plan for Post-Commissioning Condition Monitoring (in Addition to those in Table 8.8.3.9-1 if Field Coating is Required)

Potential Quality Concerns	<ul style="list-style-type: none"> • Improper location resulting in misleading data • Improper installation resulting in failure to function as designed • Damage to equipment during handling, installation, or backfilling • Failure to appropriately mark and record the location resulting in inability to locate the instrumentation in the future or susceptibility to equipment damage from 3rd party activity
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • SME selects applicable technology and location in accordance with pipeline integrity plan objectives and procedures • Second SME reviews and approves selection and location • Written procedure describes installation, backfill, and calibration requirements • Verify proper function of the equipment before and after backfilling
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Training and/or certification of personnel doing the installation and calibration, as required for the specific technology • Training in coating repair • Awareness by heavy equipment operators of care required during backfilling and compaction • Ability to generate or determine exact physical location/coordinates
Inspection Requirements	<ul style="list-style-type: none"> • Visual inspection of installation by SME • Inspection of coating repair, if applicable • Witness backfilling operation • Inspect above grade termination of cables/wires for weather tightness and physical security
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • SME trained in the specific equipment being installed • Familiarity with backfilling procedures and specifications • Familiarity with coating repair practices and inspection
Records Requirements	<ul style="list-style-type: none"> • Pipe attachment report, which includes: <ul style="list-style-type: none"> ◦ Precise location of each attachment for correlation with ILI reports ◦ Total number of unsuccessful/successful attempts to attach the lead to the pipe ◦ Equipment type, manufacturer, serial numbers, warranty information, if applicable • Coating inspection reports, including documentation of coating type, manufacturer, lot numbers, etc. • Calibration information or baseline measurements and date, as applicable

8.8.3.14 Pipe Weighting

Pipe weighting is performed where the pipeline has buoyancy approximately equal to or greater than the surrounding soil/water environment. Consideration should be given to all phases of pipeline construction and operation when calculating buoyancy, for example a liquid pipeline displaced with nitrogen for maintenance activities. Similarly, changes to the environment should be considered such as seasonal wetlands, intermittent streams, floodplains, etc. Pipe can be weighed down by several methods including, for example, cast concrete saddles, sand bag saddles, or concrete coated pipe. The installation of pipe weights must be performed properly to prevent coating or pipe damage and to achieve stability of the pipe and saddle (i.e. the pipe will not float or shift). When using saddles, the effects of point loads due to saddle weight, spacing and bottom stability should be considered to mitigate the risk of differential settlement, axial loading and/or deformation of the carrier pipe. The installation of saddles over girth welds should be avoided.

Industry standards that are applicable to pipe weighting include, but are not limited to:

- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;*
- ASME B31.8, Gas Transmission and Distribution Piping Systems;*
- DNV-OS-F101, Submarine Pipeline Systems; and*
- ISO 21809-5, Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 5: External concrete coatings.*

The potential quality concerns and options for quality control measures for pipe weighting are contained in Table 8.8.3.14-1, below. Additionally, Table 8.8.3.14-1 shows the required training/competency of personnel performing pipe weighting, as well as the inspection and records requirements.

Table 8.8.3.14-1 Minimum Considerations for Development of Pipe Weighting Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Pipe or coating damage when utilizing saddles • Pipe coating incompatibility with concrete coating • Insufficient weighting, leading to pipe rising or shifting • Unstable substrate resulting in differential settlement or buckling • Insufficient spacing of weights resulting in pipe rising or localized deformation • Unidentified environmental conditions along the ROW
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Compatibility testing of concrete coating with pipeline coating • Water absorption testing of weights, as applicable • Pipe weighting design specification review • ROW review and route selection • Pipe weighting procedures documented and known to relevant personnel <ul style="list-style-type: none"> ◦ Approved weighting options ◦ Installation of rock shield material under saddle weights to prevent coating damage ◦ Confirmation of concrete coating thickness • Consistent documentation procedures/ forms for inspections and verifications • Documentation of type and locations of weighting utilized • Documented pipe and coating repair procedures
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of company pipe weighting procedures • Ability to operate equipment required for pipe weighting • Ability to judge the acceptability of pipe and coating damage and perform pipe and coating repairs in accordance with project specifications
Inspection Requirements	<ul style="list-style-type: none"> • Witnessing and documentation of the pipe weighting activities to verify no damage to the pipe or coating occurs • Verification of weighting materials, location, and spacing • Inspection of pipe and coating repairs
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company specifications • Ability to take required measurements
Records Requirements	<ul style="list-style-type: none"> • Daily Inspection Reports • Abnormalities or deviations from specifications, recorded as NCR, to be addressed prior to backfilling activities • Ability to perform inspections applicable to the types of repairs performed and to judge the acceptability of the repairs based on comparison to project specifications • Documentation of repairs in appropriate format

8.8.3.15 As-Built Surveying

As-built surveying is the process of collecting and documenting all of the pipeline attributes and their associated location and installation conditions along a pipeline. As-built surveying should be coordinated with as-built documentation (addressed in Section 8.8.3.22) in which the survey results and associated component and test documentation are tied into a completed as-built package. An accurate and properly documented as-built package of a completed pipeline is needed for verifiable, traceable, and complete records. Additionally, it is an invaluable tool for future maintenance and construction on or around the pipeline. The process of creating an as-built package starts as soon as pipeline construction begins and should be carried out on a daily basis. This process should involve recording each day's construction activities including the installation of each joint of pipe and piping component (e.g. valves, flanges, tees, elbows, etc.) This will facilitate finalizing the as-built package in a timely manner at the end of construction.

The data that should be considered for collection as part of the as-built survey process is as follows.

- *Each pipe location and associated attributes:*
 - *Outside diameter;*
 - *Wall thickness;*
 - *Material specification and grade/type;*
 - *Weld seam type (or seamless);*
 - *Heat number;*
 - *MTR reference (plate mill, pipe mill, actual yield strength, chemistry, and carbon equivalent);*
 - *Coating type and mill;*
 - *Length of the pipe joint;*
 - *Seam weld orientation;*
 - *Elevation;*
 - *Depth of cover;*
 - *Construction chainage of the upstream and downstream girth welds;*
 - *Pipe protection type (such as rock shield), as applicable; and*
 - *Buoyancy control method (such as weights or concrete coating), as applicable.*
- *Each girth weld location and associated NDT and disposition records:*
 - *GPS coordinates of welds and appurtenances;*
 - *Girth weld number upstream and downstream;*
 - *Girth weld WPS;*
 - *Location of repairs;*
 - *NDT type and record, including acceptable/ rejectable indications and disposition for inspected welds; and*
 - *Coating type.*
- *Each component (e.g., valve, bend, fitting, tee), corrosion test station, anode, and appurtenance (e.g., support) location and associated attributes:*
 - *GPS coordinates of components, test stations, anodes, and appurtenances;*
 - *Bend angle, direction (e.g., vertical, horizontal), and type of bend (field, induction, elbow); and*
 - *Component number reference (to tie back to design attributes, MTR, and associated test documentation).*
- *Each crossing location (pipeline, overhead, buried utility, etc.) and associated information:*
 - *Type of crossing (include casing type, grade, OD, WT, inspection records when applicable); and*
 - *GPS coordinates of all crossings.*
- *Additional construction and test information:*
 - *Installed pipe length;*
 - *Terrain and soil conditions including soil resistivity;*

- Test pressure (%SMYS) and duration;
- Documentation of excess pipe;
- Spread and test section number; and
- Contractor(s).

At minimum, pipeline projects falling under the jurisdiction of 49 CFR 195 should meet the construction record requirements outlined in 49 CFR 195.266.

The potential quality concerns and options for quality control measures for as-built surveying are contained in Table 8.8.3.15-1, below. Additionally, Table 8.8.3.15-1 shows the required training/competency of personnel performing as-built surveying, as well as the inspection and records requirements.

Table 8.8.3.15-1 Minimum Considerations for Development of As-Built Surveying Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Data not recorded in a timely fashion during construction • Data not recorded prior to burial • Poor data alignment and quality • Missing data • Inaccurate data • Data loss after collection
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Appropriate as-built surveying procedures in place and known to relevant personnel. The procedures should include when, how, and by whom pipeline data will be captured. • Formal and continuous QA of collected data to verify accuracy of pipe attributes and locations • A single point of responsibility assigned for as-Built documentation • Periodic back-up of collected data
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of company as-built surveying procedures and forms • Ability to identify pipeline components and required information for documentation • Ability to utilize GPS equipment and/or equipment used to document location and other relevant information
Inspection Requirements	<ul style="list-style-type: none"> • Field audits to verify the as-built surveying procedures are being followed • Regular inspection of collected data for consistency and accuracy (daily if practicable) • Verification of locating equipment accuracy
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company as-built surveying procedures • Familiarity with project details, locations, and materials being used
Records Requirements	<ul style="list-style-type: none"> • Consideration should be given to regular transfers of as-built survey information to as-built drawings for larger projects (e.g., monthly, or as determined by the operating company) • All records should be maintained for the life of the pipeline • Redundant copies of the completed as-built documentation should be maintained

8.8.3.16 Backfilling

Backfilling is the replacement of the soil in the trench surrounding the installed pipeline. Backfilling is performed in the reverse order of ditching to maintain the natural segregation of soil layers. However, if the subsoil material is inappropriate for contact with the pipeline, it should be filtered to remove rocks or non-native material such as sand should be used for the initial "shading" of the pipe. If this is impractical, rock shield should be utilized to protect the pipeline from coating and pipe body damage. The type(s) and location(s) of any non-native backfill material or rock shield should be recorded and assessed with regards to external corrosion susceptibility, monitoring, and mitigation. Consideration should be given to the use of trench barriers or terracing on slopes to prevent erosion of the ditch line or loss of pipe padding due to surface water intrusion. This is especially relevant in areas where rock or fully consolidated soils are present.

The main concerns during backfilling include proper support of the pipe and prevention of damage to the pipe coating or body due to improper backfill materials or accidental contact with the backfilling equipment. Secondary concerns during backfill include the proper soil lift heights, compaction, and depth of cover.

Industry standards that are applicable to backfilling include, but are not limited to:

- *ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries; and*
- *ASME B31.8, Gas Transmission and Distribution Piping Systems.*

The potential quality concerns and options for quality control measures for backfilling are contained in Table 8.8.3.16-1, below. Additionally, Table 8.8.3.16-1 shows the required training/competency of personnel performing backfilling, as well as the inspection and records requirements.

Table 8.8.3.16-1 Minimum Considerations for Development of Backfilling Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Coating damage or denting due to backfill materials • Coating damage or denting due to pipeline contact with backfilling equipment • Unsupported pipeline due to non-compacted backfill material between sand-bags or pillows • Reduced effectiveness of cathodic protection system due to improper rock shielding, backfill voids, or foreign materials adjacent to the pipe surface
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Inspection and documentation of backfill materials prior to use to determine appropriateness (rock to soil ratio) and verify it is free of foreign objects • Backfill procedures documented and known to relevant personnel <ul style="list-style-type: none"> ◦ Approved backfilling equipment, including required screen size for padding machines ◦ Required clearance between backfilling equipment and installed pipeline ◦ Lift heights, compaction requirements, and watering requirements, as applicable ◦ Backfill crown requirements and minimum depth of cover • Documentation of type and locations of rock shield utilized when backfill materials may cause coating damage • Documented pipe and coating repair procedures
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Ability to determine suitability of backfill materials and requirements for rock shield based on comparison of project specifications and available backfill • Understanding of company backfilling procedures • Ability to operate backfilling equipment • Ability to judge the acceptability of pipe and coating damage and perform pipe and coating repairs in accordance with project specifications
Inspection Requirements	<ul style="list-style-type: none"> • Inspection of backfill materials prior to use to confirm and document appropriateness • Witnessing and documentation of the backfill activities to verify no damage to the pipe or coating occurs • Monitoring and documentation of compliance with compaction requirements
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company backfill procedures • Ability to take required measurements (lift heights, compaction, crown height, depth of cover, etc.) • Ability to perform inspections applicable to the types of repairs performed and to judge the acceptability of the repairs based on comparison to project specifications

Table 8.8.3.16-1 Minimum Considerations for Development of Backfilling Procedures and Quality Plan (continued)

<i>Records Requirements</i>	<ul style="list-style-type: none">• <i>Daily inspection report, including location and type of non-native backfill or rock shields</i>• <i>Improper backfilling immediately halted, recorded as NCR, and addressed prior to continuation of backfilling activities</i>• <i>Damaged pipe or coating, recorded as an NCR, and addressed prior to continuation of backfilling activities</i>• <i>Backfill temperature, if needed for thermal load calculations</i>• <i>Documentation of repairs in appropriate format</i>
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8.8.3.17 Tie-Ins

Tie-ins are welds made between two sections of installed piping (i.e., pipe in the ditch). The information contained in Sections 8.8.3.7.1, Welding, and 8.8.3.8, Non-Destructive Testing (NDT) of Welds, is applicable to tie-ins, with the addition of concerns listed in this section. Tie-in welds may be subject to higher stresses than mainline welds due to potential fit-up issues and thermal stresses. Fit-up of the pipe joint ends at a tie-in weld may be more difficult due to the restraint resulting from long lengths of pipe being joined, as opposed to single pipe joints. Jacking, hammering, or other forceful methods of alignment should be avoided as these can increase residual stresses, and thus susceptibility to failure, in the completed weld. Additionally, axial thermal stresses on installed pipelines are related to the temperature difference between the operating and installation temperatures; higher installation temperatures contribute to axial tensile stresses during operation. Future fitness for service (FFS) assessments on the completed pipeline may require accurate installation temperature information.

Industry standards that are applicable to tie-ins include, but are not limited to:

- *API 1104, Welding of Pipelines and Related Facilities;*
- *ASME Boiler and Pressure Vessel Code (BPVC), Section IX, Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators;*
- *ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries; and*
- *ASME B31.8, Gas Transmission and Distribution Piping Systems.*

The potential quality concerns and options for quality control measures for tie-ins are contained in Table 8.8.3.17-1, below. Additionally, Table 8.8.3.17-1 shows the required training/competency of personnel performing tie-ins, as well as the inspection and records requirements.

Table 8.8.3.17-1 Minimum Considerations for Development of Tie-In Procedures and Quality Plan (in Addition to those in Table 8.8.3.7-1 and 8.8.3.8-1)

Potential Quality Concerns	<ul style="list-style-type: none"> • Difficulty in achieving proper weld joint fit up <ul style="list-style-type: none"> ◦ Increased residual stresses ◦ Increased probability of weld flaws • Increased thermal stresses in the weld due to differences in installation and operating temperatures
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Documented tie-in procedures <ul style="list-style-type: none"> ◦ Limitation on methods used to achieve proper joint fit up ◦ Specification of allowable tie-in temperature range • Increased documentation requirements for tie-in welds to verify compliance with tie-in procedures • Utilization of an X-ray source for NDT or consideration given to using Class I film for radiography • Welding inspector onsite throughout the fit-up and welding processes
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Understanding of company tie-in procedures • Understanding of tie-in fit up requirements and limitations of methods used to obtain alignment and fit up
Inspection Requirements	<ul style="list-style-type: none"> • Witnessing and documentation of joint fit-up to verify that excessive stresses are not induced in the weld • Determination and documentation of installation temperature, as required
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Understanding of company tie-in procedures • Understanding of tie-in fit up requirements and limitations of methods used to obtain alignment and fit up
Records Requirements	<ul style="list-style-type: none"> • Tie-in inspection report (in addition to the requirements of a weld inspection report) <ul style="list-style-type: none"> ◦ Fit up achieved (high-low measurements) ◦ Installation temperature ◦ Supplemental welding requirements that exceed the minimum requirements of the WPS (for example, postweld heating)

8.8.3.18 Special Cases

Special cases that may be applicable to pipeline projects include horizontal directional drills (HDDs); crossing and casings; fabrications such as valves, segmented bends, or interconnects; and tracer wires for plastic pipe projects. These special cases are discussed in Sections 8.8.3.18.1 through 8.8.3.18.4.

8.8.3.18.1 Horizontal Direction Drill (HDD)

Horizontal directional drilling (HDD) is a method of pipeline installation that utilizes steerable soil drilling systems. HDD is primarily utilized to navigate obstructions in the pipeline ROW (e.g., rivers, shorelines, roads, railways, etc.) because it has far less surface impact than traditional cut-and-cover methods. The installation is generally accomplished in three stages: drilling of a small diameter pilot hole along the designed drill path; enlarging the pilot hole to a diameter that will accommodate the pipe (reaming); and pulling the pipeline back through the enlarged hole (pullback).

Proper design, equipment selection, and implementation of the HDD are necessary to minimize the likelihood of impact of the HDD on the integrity of the pipe, the surrounding construction area, neighboring utilities, or the environment.

Industry standards and best practice documents that are applicable to HDDs include, but are not limited to:

- *ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;*
- *ASME B31.8, Gas Transmission and Distribution Piping Systems;*
- *PRCI L52290, Installation of Pipelines By Horizontal Directional Drilling, An Engineering Design Guide;*
and
- *HDD Consortium, Horizontal Directional Drilling Good Practices Guidelines.*

The potential quality concerns and options for quality control measures for HDDs are contained in Table 8.8.3.18-1, below. Additionally, Table 8.8.3.18-1 shows the required training/competency of personnel performing HDDs, as well as the inspection and records requirements.

Table 8.8.3.18-1 Minimum Considerations for Development of HDD Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none">• Plastic deformation of the pipe due to overstressing of the material• Girth weld flaw growth (fatigue or overstrain)• Mechanical damage of the pipe or coating• Buckling or kinking (overstraining) pipe during installation• Damaged coating (Note: abrasion resistant overlay, ARO, is less flexible than standard fusion bonded epoxy, FBE)• Loss of drilling fluid due to poor soil characteristics resulting in stuck pipe, high tensile loads, and potential pipe damage• Inadvertent release of drilling fluids to the surface/environment due to hydro fracture of the surrounding soil• Damage to the surface infrastructure due to surface heave or soil settlement• Stuck pipe or lost equipment in the borehole• Damage to neighboring utilities or pipelines• Improper disposal of drilling fluids• Inaccurate construction of the designed drill path
QA/QC and Mitigation Options	<ul style="list-style-type: none">• Review of the proposed HDD profile• Review of the as-built HDD profile and associated strain levels• Perform close visual inspection of the girth welds prior to NDT• Perform NDT and review the NDT records for all anomalies in girth welds• Review of the coating type and susceptibility for coating damage at weld seams• Perform and review the geotechnical survey for classification of the subsurface structure<ul style="list-style-type: none">◦ Verify adequate drilling fluid program is in place◦ Verify equipment is well-suited for soil conditions• Written specification/procedure for extraction of stuck pipe string, known to relevant personnel• Written procedure for disposal of drilling fluids, known to relevant personnel, which meets all jurisdictional requirements• Identification and avoidance of neighboring utilities and pipelines• Account for inaccuracies of drill head tracking equipment during design and construction<ul style="list-style-type: none">◦ Identify sources of interference with tracking equipment
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none">• Contractor should have experience or sufficient knowledge of working in the soil conditions present at the project site.• Geotechnical survey should be performed by a qualified engineer or someone with adequate knowledge and training• Designer of the drill path should understand the results of the geotechnical survey and how they impact the design path• Ability to operate all equipment proposed for use on the project

Table 8.8.3.18-1 Minimum Considerations for Development of HDD Procedures and Quality Plan (continued)

<i>Inspection Requirements</i>	<ul style="list-style-type: none"> • Confirmation of the as-bored HDD profile • Pipe string entry profile • Weld inspection, including visual inspection and other inspections as required by the project specification. This could include spot radiography or other NDT methods • Coating inspection as required by the project specification • Geotechnical survey • Utility survey
<i>Training/Competency of Inspection Personnel</i>	<ul style="list-style-type: none"> • Ability to recognize coating damage and conditions that promote coating damage • Ability to perform inspection of the welding and completed welds (visual) • Certified to ASNT SNT TC-1A Level II or III for interpretation of NDT results, if applicable
<i>Records Requirements</i>	<ul style="list-style-type: none"> • Documentation of technical feasibility of project • Documentation of underground facilities (pipelines, cables, buried structures, etc.) and a written safety plan to include contingency plans in the event the drilling string impacts a subsurface facility. • Documentation of subsurface conditions • Documentation of HDD design and as-built drawings • Plan for containment and disposal of drilling fluid • Hydrostatic test plan that should consider pre-testing the fabricated string prior to installation • Welding procedure specifications and weld inspection reports • Documentation of pulling operation, including pull forces as a function of displacement of the pull head

8.8.3.18.2 Cased Crossings

Cased crossings are crossing where the pipeline is installed inside of a larger diameter pipe called a casing, under a road, railroad, or bridge crossings. Centralizers are utilized to maintain electrical isolation of the pipeline from the casing.

Cased crossings serve the following purposes:

- They allow piping to be removed and reinstalled without interfering with the operation of the road, railway, or bridge;
- They provide mechanical protection from cyclic loads related to trains and motor vehicles, and from mechanical damage from nearby activities associated with bridges; and
- They can convey leaking product away from the bridge, road or railway via the casing vents (when equipped with vents) or through open casing ends if the casing is above grade, i.e., on a bridge.

However, casings can result in the following disadvantages:

- They can interfere with effective CP of the carrier pipeline, especially if the pipeline is electrically shorted to the metallic casing or the casing is very long;
- It is more difficult to assess the condition of cased pipelines using typical indirect inspection methods used in external corrosion direct assessment surveys and during in-line inspections;
- Improper assembly of the casing, failure to properly install the correct type and number of insulators, or careless handling of the carrier pipe during installation can result in damage to the external coating on the carrier pipe, leaving the pipe vulnerable to corrosion by the environment inside the casing, particularly if the casing is not leak-tight or if condensation occurs on the pipeline surface; and
- The condition of end seals and of the casing itself is difficult to monitor, therefore it may not be obvious that the casing integrity has been lost and/or that corrosive soil or water is entering the casing.

While casings have become increasingly unpopular among corrosion engineers, they continue to be commonly specified by transportation authorities and railroads as a method for facilitating the crossing of roads, bridges, and railroads. Some of the disadvantages and vulnerabilities of cased crossings can be prevented or mitigated through careful design and installation practices. Alternatively, heavier wall pipe may provide similar benefits to casing with fewer disadvantages.

Industry standards that are applicable to cased crossings include but are not limited to:

- API Recommended Practice 1102, *Steel Pipelines Crossing Railroads and Highways*, December 2008
- American Railway Engineering and Maintenance-of-Way Association, *Manual for Railway Engineering Part 5*, 2008 (or other railroad-related specifications and standards that may be specific to one or more railway operators)
- NACE Standard Practice SP0200-2008, *Steel-Cased Pipeline Practices*
- ASME B31.4, *Pipeline Transportation Systems for Liquids and Slurries*; and
- ASME B31.8, *Gas Transmission and Distribution Piping Systems*.

The potential quality concerns and options for quality control measures for cased crossings are contained in Table 8.8.3.18-2, below. Additionally, Table 8.8.3.18-2 shows the required training/competency of personnel installing cased crossings, as well as the inspection and records requirements.

Table 8.8.3.18-2 Minimum Considerations for Development of Cased Crossing Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Damage to pipeline coating during installation • Selection of incorrect pipeline casing design (diameter, thickness, material, depth of cover) that does not meet specifications or applicable regulations • Failure to consider corrosiveness of the soil environment and the long term effect on the casing integrity when selecting casing materials, thickness and corrosion mitigation measures (if any) • Improper design or installation of casing end seals • Improper type or location or inadequate number of casing insulators (spacers) leading to immediate or eventual metallic short of pipeline to casing and/or eccentricity of the casing with respect to the carrier pipe • Improper assembly of the casing leading to leakage, unintentional deviations from straightness, weld metal projecting into the inside of the pipe resulting in damage to the pipe coating during pipe installation, and/or eccentricity of the casing with respect to the carrier pipe
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Review of welding procedure specifications and welder qualification requirements • Review of design compared with specifications and applicable regulations • Documented comparison of as-built casing with casing specification • Review of welding inspection records
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Familiarity with casing construction practices and the project specifications, including interpretation of design drawings • Ability to operate equipment used to insert pipe into the casing • Welder qualified in accordance with project specifications • Trained in installation of casing insulators (location and attachment method)
Inspection Requirements	<ul style="list-style-type: none"> • Weld inspection, including visual inspection and other inspections as required by the project specification. This could include spot radiography or other NDT methods • Verification and documentation of casing insulator installation on pipe • Inspection of casing end seal installation • Witnessing of pipeline installation with specific attention to prevention of coating damage • Inspection of casing insulators • Verify absence of metallic short between casing and pipe after installation

Table 8.8.3.18-2 Minimum Considerations for Development of Cased Crossing Procedures and Quality Plan (continued)

<i>Training/Competency of Inspection Personnel</i>	<ul style="list-style-type: none"> • <i>Ability to recognize coating damage and conditions that promote coating damage</i> • <i>Ability to perform inspection of the welding and completed welds (visual)</i> • <i>Certified to ASNT SNT TC-1A Level II or III for interpretation of NDT results, if applicable</i> • <i>Trained in recognition of proper casing end seal installation</i> • <i>Ability to check for casing shorts</i>
<i>Records Requirements</i>	<ul style="list-style-type: none"> • <i>Documentation of casing design (diameter, wall thickness, materials, location and design of vents, description of end seals) and conformance with applicable specifications and regulations</i> • <i>As-built drawings including documentation of casing end locations and vent details</i> • <i>Welding procedure specifications, welder qualification records, and weld inspection reports</i>

8.8.3.18.3 On-Site or Off-Site Fabrications

Fabrications include valve settings, segmented bends, interconnects, in-line inspection (ILI) tool launchers and receivers, station piping, skids, etc. Fabrications may be built at a remote location from the main pipeline construction (shop fabrication) or at a fabrication yard(s) as part of the main construction effort. Fabrication tends to have less inspection oversight as multiple activities are performed simultaneously (welding, coating, etc.). Additionally, fabricators tend to have a quality program, but not a comprehensive QMS.

Industry standards that are applicable to fabrications include, but are not limited to:

- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;*
- ASME B31.8, Gas Transmission and Distribution Piping Systems;*
- API 1104, Welding of Pipelines and Related Facilities;*
- ASME Boiler and Pressure Vessel Code (BPVC), Section IX, Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; and*
- ASNT SNT-TC-1A, Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing.*

Quality control concerns for fabrications include those associated with workmanship and adherence to design specifications and drawings. Fabrications are often shipped to the final installation site skid mounted, or as finished assemblies or spool pieces. Coatings may consist of finished top coats or only primers. To enable alignment and fit-up with field construction, including, but not limited to piping connection, power supplies, foundations, and auxiliary connections, dimensions need to be strictly controlled and verified.

Installation of components such as valves, closures, etc. should be verified to confirm proper operation and conformance with the manufacturer's installation procedures. Components provided with the fabricated assembly to be installed at the final location should be clearly identified. Installation instructions, operating manuals, parts lists, and shipping manifests should be provided prior to delivery or accompany the fabrication to the final location.

To verify the final fabrication meets design requirements, consideration should be given to procedures for the approval of drawings for fabrication, MOC for deviations, and the issuance of as-built drawings.

Welding and joining quality concerns are addressed in Section 8.8.3.7.1, Welding, and 8.8.3.7.2, Joining, above. Additionally, transportation and handling quality concerns are addressed in Section 8.7.11, Transportation and Handling. Since fabrication often involves branch connections, wall thickness transitions, and fittings, the drawings and specifications should be closely reviewed to verify the WPS includes all weld design requirements. Attention to weld geometry and fit-up should be monitored, especially when using pipe cut for spools which may have body dimensional tolerances different from ends finished at the manufacturer. Ovality resulting in high-low should be controlled and consideration given to segmentable fittings and/or bends during fabrication. Squareness of pipe ends and flange faces should be controlled and verified to facilitate proper fit-up following delivery. Consideration should also be given to the passage of internal inspection tools if the assembly is to be installed on a piggable line segment (i.e. valve sets).

Documentation of assembly specifications and monitoring of assembly procedures should include mechanical connections, for example flange tightening sequences, torque requirements, tubing connections, and gaskets. Pressure classifications and ratings of all flanges, valves and components should be verified to confirm fitness for the intended service. Similarly, specifications for valve trim, seals, and elastomers should be reviewed to verify compatibility with the material being transported.

Operability and acceptance testing of complex skid mounted systems may be conducted at the fabricator prior to shipping. Acceptance testing will typically be witnessed by a company representative. Acceptance testing should include component operation, NDT and hydrostatic testing as appropriate.

The potential quality concerns and options for quality control measures for fabrications are contained in Table 8.8.3.18-3, below. Additionally, Table 8.8.3.18-3 shows the required training/competency of personnel installing fabrications, as well as the inspection and records requirements.

Table 8.8.3.18-3 Minimum Considerations for Development of Fabrication Procedures and Quality Plan

<p>Potential Quality Concerns</p>	<p>Assembly or Component Concerns</p> <ul style="list-style-type: none"> • Incorrect assembly fabricated • Incorrect pressure rating of assembly or components • Assembly dimensions out of specification, for example: <ul style="list-style-type: none"> ◦ Diameter, wall thickness, ovality, squareness of pipe connections ◦ Inlet, outlet, centerline and/or foundation dimensions ◦ Coating thickness and adhesion • Failure to identify imperfections or defects that could impact short term or long term integrity and performance of the constructed pipeline, for example: <ul style="list-style-type: none"> ◦ Material imperfections ◦ Mechanical connections ◦ Weld defects ◦ Coating holidays ◦ Incorrect trim, seals or gaskets • Damage during transportation or handling • Damage to or contamination of primer coatings prior to finish coating <p>Documentation Concerns</p> <ul style="list-style-type: none"> • Documentation incomplete, unavailable or not provided with assembly • Incomplete documentation of traceability for materials, components, consumables, and/or inspection and testing results • Incorrect marking or identification
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Table 8.8.3.18-3 Minimum Considerations for Development of Fabrication Procedures and Quality Plan (continued)

<p><i>QA/QC and Mitigation Options</i></p>	<ul style="list-style-type: none"> • <i>Inspection of materials for adherence to specifications and for damage</i> <ul style="list-style-type: none"> ◦ <i>Verification of dimensions</i> ◦ <i>Verification of pressure class ratings</i> ◦ <i>Verification of product compatibility (i.e. valve trim and seals)</i> ◦ <i>Verification of coating type, surface preparation and thickness</i> • <i>Verification of associated markings and documentation</i> <ul style="list-style-type: none"> ◦ <i>Verification of material markings, specifically dimensions, material, manufacturer, pressure rating/class, serial number, date of manufacture, monogram program, and other applicable information</i> ◦ <i>Verification of MTRs for completeness, and that all requirements for testing and inspection were met</i> • <i>Procedure developed for identifying nonconformances and documenting via nonconformance reports (NCRs)</i> • <i>Procedure developed for transportation/ handling of fabrications</i> • <i>Consistent documentation procedures/forms for inspections and verifications</i>
<p><i>Training/Competency of Personnel Performing Activities</i></p>	<ul style="list-style-type: none"> • <i>Ability to read specifications and drawings</i> • <i>Ability to identify/use appropriate fabrication tools/equipment</i> • <i>Ability to use relevant inspection instruments and gauges</i> • <i>Understanding of NDT procedures</i> • <i>Understanding of applicable industry standards, code requirements and purchaser specifications</i> • <i>ASNT SNT-TC-1A Level I, II, or III as required (only Level II and Level III may interpret NDT results and determine acceptance of a particular inspection)</i> • <i>Understanding of fabrication transportation/ handling procedures</i>

Table 8.8.3.18-3 Minimum Considerations for Development of Fabrication Procedures and Quality Plan (continued)

<p><i>Inspection Requirements</i></p>	<ul style="list-style-type: none"> • <i>Conformance with drawings approved for fabrication</i> • <i>Verification of pressure class ratings for all components</i> • <i>Verification of specified trim, seals, gaskets, etc.</i> • <i>Monitoring of mechanical connections for compliance with specifications and procedures</i> • <i>Witnessing of operability and acceptance testing.</i> • <i>Visual inspection of weld bevel and joint fit-up by the welder</i> • <i>Audit of welding parameters and WPS requirements by the inspector (per the frequency deemed appropriate)</i> <ul style="list-style-type: none"> ◦ <i>Visual inspection of weld bevel and joint fit-up</i> ◦ <i>Welding consumables</i> ◦ <i>Shielding gas and flow rates</i> ◦ <i>Preheat temperature and maintenance</i> ◦ <i>Welding parameters (amperage, voltage, travel speed, heat input, etc.)</i> ◦ <i>Lineup clamp removal (with relation to root and hot pass completion)</i> ◦ <i>Minimum number of weld beads required</i> ◦ <i>Weave limits or bead placement, as applicable</i> ◦ <i>Time between passes</i> • <i>Cleaning/grinding between passes</i> • <i>Visual inspection and NDT of completed weld</i> • <i>Inspection of transportation and handling methods</i>
<p><i>Training/Competency of Inspection Personnel</i></p>	<ul style="list-style-type: none"> • <i>Understanding of purchaser specifications, drawings, and WPS</i> • <i>Ability to take required measurements</i> • <i>Ability to recognize manufacturing defects and non-conforming documentation</i> • <i>Ability to recognize the completeness of applicable procedures</i> • <i>Ability to interpret and confirm NDT results</i> • <i>ASNT SNT-TC-1A Level I, II, or III as required</i> • <i>Ability to measure welding parameters, including voltage, current, travel speed, and in some cases heat input</i> • <i>Ability to check compliance with project WPS (consumables, time between passes, welding parameters, etc.)</i> • <i>Understanding of the proper application and maintenance of preheat</i> • <i>Personnel inspecting coating must exhibit the knowledge, skills and ability to verify effective coating application</i> • <i>NACE Certified Coating Inspector – Level 3, or other, as required</i> • <i>Understanding of applicable transportation and handling procedures</i>

Table 8.8.3.18-3 Minimum Considerations for Development of Fabrication Procedures and Quality Plan (continued)

Records Requirements	<ul style="list-style-type: none"> • <i>Inspection forms completed in accordance with procedures</i> • <i>Associated documentation packages, preferably stored in electronic format. These documents may be sent independently of the fabrication or component, and they may contain, for example:</i> <ul style="list-style-type: none"> ◦ <i>Operations and maintenance manuals for components</i> ◦ <i>Operation and acceptance testing results</i> ◦ <i>Installation instructions or manuals</i> ◦ <i>As-built drawings</i> ◦ <i>Shipping tallies, parts lists, etc.</i> • <i>Abnormalities or deviations from specifications, recorded as NCR, to be addressed by quarantine plan</i> • <i>Any anomalies that were deemed acceptable and that may appear on future ILI runs should be well documented and brought to the attention of the as-built project team and operations group</i> • <i>Documentation acknowledging receipt and understanding of transportation and handling requirements/procedures</i>
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8.8.3.18.4 Tracer Wires

Metallic tracer wires are utilized as a locating method for plastic piping. Alternately, plastic coated metallic tape or other proven methods may be utilized.

Industry standards that are applicable to tracer wires include, but are not limited to:

- *ASME B31.8, Gas Transmission and Distribution Piping Systems.*

The potential quality concerns and options for quality control measures for tracer wires are contained in Table 8.8.3.18-4, below. Additionally, Table 8.8.3.18-4 shows the required training/competency of personnel installing tracer wires, as well as the inspection and records requirements.

Table 8.8.3.18-4 Minimum Considerations for Development of Tracer Wire Procedures and Quality Plan

<i>Potential Quality Concerns</i>	<ul style="list-style-type: none">• <i>Improper installation of tracer wire, leading to uncertainty in plastic pipe locations</i><ul style="list-style-type: none">◦ <i>Tracer wires not installed on all sections, as required</i>◦ <i>Tracer wires not brought to the surface at riser locations</i>◦ <i>Damage during backfilling</i>• <i>Incomplete electrical continuity throughout the piping system</i><ul style="list-style-type: none">◦ <i>Damaged insulation</i>◦ <i>Wire shorting</i>◦ <i>Inadequate connections</i>◦ <i>Broken wire</i>
<i>QA/QC and Mitigation Options</i>	<ul style="list-style-type: none">• <i>Tracer wire procedures documented and known to relevant personnel</i><ul style="list-style-type: none">◦ <i>Approved wire type, including gauge, insulation, color, etc.</i>◦ <i>Approved connection methods</i>◦ <i>Confirmation of electrical conductivity</i>• <i>Consistent documentation procedures/ forms for inspections and verifications</i>
<i>Training/Competency of Personnel Performing Activities</i>	<ul style="list-style-type: none">• <i>Understanding of company tracer wire procedures</i>
<i>Inspection Requirements</i>	<ul style="list-style-type: none">• <i>Continuity testing of all tracer wires prior to backfilling activities</i>• <i>Confirmation of required excess tracer wire at terminations</i>
<i>Training/Competency of Inspection Personnel</i>	<ul style="list-style-type: none">• <i>Understanding of company tracer wire procedures</i>• <i>Ability to take required measurements</i>
<i>Records Requirements</i>	<ul style="list-style-type: none">• <i>Daily Inspection Reports, including locations of all tracer wire access points</i>• <i>Abnormalities or deviations from specifications, recorded as NCR, to be addressed prior to backfilling activities</i>

8.8.3.19 Pre-Commissioning Pressure Testing

Pre-commissioning pressure testing is most commonly performed with water, and called hydrostatic testing, or hydrotesting. Benefits of pre-commissioning pressure tests include:

- Proof of leak tightness in the pipe, fittings and components, and joining locations;*
- Detection and elimination of manufacturing flaws and flaws that may have been introduced during shipping, handling, or construction; and*
- Establishment of the operating pressure.*

Pre-commissioning pressure testing is performed to detect flaws that can potentially affect the long term integrity of the pipeline. Flaw detection is achieved by subjecting the flaws to pressures that exceed the (reduced) pressure capacity in the area of the flaw, resulting in failure of the pipe or component at that location. It should be noted that pressure tests are not efficient at detecting susceptibility to failure from large axial strains. They are best used as indicators of resistance to stresses from internal pressures only and may provide a false sense of the ability of the pipeline or existing flaws to withstand strains from ground deformation or detect flaws in girth welds.

As compared to mill pressure testing, pre-commissioning pressure testing can sometimes be performed at higher pressures (allowing detection of additional flaws) and are generally held at pressure much longer (allowing more time for leaking defects to expose themselves). Pre-commissioning pressure testing in the field can detect flaws that were not detected during testing and inspection by the manufacturer and flaws that were generated during shipping, handling, fabrication or installation of the pipe and pipeline components. Pre-commissioning pressure testing can also reveal the presence of pipe or components having lower than expected yield strength. In that case, the testing more often results in permanent radial expansion of the pipe or fitting, rather than failure. The expansion might not become apparent until caliper in-line inspection (ILI) tools are utilized to inspect the pipeline.

When pressure testing existing pipe with new pipeline sections, it is possible to have a flaw extend by stable crack growth so that it becomes susceptible to failure at pressures lower than what it survived during earlier pressure tests (i.e., ductility exhaustion leading to a pressure reversal). Older pipe (e.g. with lesser known material properties or seam issues related to older manufacturing techniques) would be expected to be more susceptible to this type of degradation than newly constructed modern pipe. Susceptibility to these test-related forms of degradation can be minimized through careful selection of test pressures and durations. For example, a "spike test" procedure could optimize test pressures and durations to find significant flaws while minimizing the likelihood of ductile crack growth during long hold times at maximum pressure.

Minimum pre-commissioning test pressures have traditionally been set by pipeline safety regulations at some multiple of the intended maximum operating pressure (MOP), for example 1.25 x MOP. However, technical advances over the last several years have shown advantages to higher test pressures than what are required by regulation. Higher test pressures will reveal smaller flaws, leaving the remaining population of relatively small imperfections with a high ratio of failure pressure to operating pressure. The relatively small flaws require more time to grow to a critical flaw size from time-dependent mechanisms (corrosion and fatigue). In some cases, remaining flaws could be small enough that they are unlikely to experience significant fatigue growth following the test. Susceptibility of remaining flaws to fatigue growth is largely dependent on operating parameters (i.e. pressure cycling) in addition to remaining flaw size.

Typically, higher test pressures provide a larger factor of safety between the intended operating pressure and the pressure that would cause remaining flaws (i.e. flaws that withstood the pressure test) to fail. The challenge in pre-commissioning pressure testing is to design a test that will remove credible threats to pipeline integrity while not inadvertently damaging pipe or fittings and while meeting regulatory requirements for both test duration and test pressure.

Industry standards that are applicable to pre-commissioning pressure testing include but are not limited to:

- *ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;*
- *ASME B31.8, Gas Transmission and Distribution Piping Systems;*
- *ASME B31.8S, Managing System Integrity of Gas Pipelines;*
- *API 1110, Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide;*
- *PPI TR-3, Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe; and*
- *INGAA Foundation Final Report No. 2013.03, "Technical, Operational, Practical, and Safety Considerations of Hydrostatic Pressure Testing Existing Pipelines."*

The potential quality concerns and options for quality control measures for pre-commissioning pressure testing are contained in Table 8.8.3.19-1, below. Additionally, Table 8.8.3.19-1 shows the required training/competency of personnel performing pre-commissioning pressure testing, as well as the inspection and records requirements.

Table 8.8.3.19-1 Minimum Considerations for Development of Pre-Commissioning Pressure Testing Procedures and Quality Plan

<p>Potential Quality Concerns</p>	<ul style="list-style-type: none"> • Minimum test pressure not calculated correctly (pressure does not meet regulatory requirements) • Test pressure not maintained for required time • Minimum test pressure not maintained over the entire test section due to elevation changes • Test medium temperature variability (i.e. heat-up or cool-down) impacts the ability to hold a constant pressure, potentially masking leaks • Entrained air (trapped during filling) could impact the ability to reliably evaluate pressure-volume relationship, detect yielding and detect small leaks • Small leaks not detected • Minimum test pressure not adequate to eliminate long term pipeline integrity concerns, despite meeting minimum regulatory requirements (for example 1.1 MAOP may not adequately reduce the likelihood for fatigue growth of seam defects) • Inadvertent damage to pipe or fittings as a result of ductility exhaustion (resulting in pressure reversal) • Inadvertent damage (i.e. plastic deformation) due to pressure induced stresses that exceed the actual yield strength of some pipe joints or fittings • Use of out-of-calibration test equipment results in pressure not accurately measured and recorded • Test pump not sized correctly, which may result in an unattainable target pressure • Test water not fully removed resulting in a corrosive environment inside the pipeline and components (e.g., valves) after testing • Inadequate test documentation or loss of documentation traceability • Improper test instrumentation set up resulting in inaccurate test medium pressure or temperature measurements
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Table 8.8.3.19-1 Minimum Considerations for Development of Pre-Commissioning Pressure Testing Procedures and Quality Plan (continued)

<p>QA/QC and Mitigation Options</p>	<ul style="list-style-type: none"> • Have adequate measures in place to review the results of the calculated minimum required test pressure • Have adequate measures in place to review the results of the hold time determination • Verify that elevation data is available with adequate resolution to reliably calculate the static pressure profile during the pressure test • Have adequate measures in place to review the results of the calculated static pressure profile • Verify the test water is cold enough to achieve temperature stabilization with a minimum impact on the test segment pressure and/or verify that sufficient time is allowed for test water temperature to reach equilibrium with surrounding soil • Utilize isolation pigs to minimize the amount of entrained air left in the pipeline • Perform a materials review to determine the expected remaining flaw size(s) following the test • Perform a seam susceptibility study (e.g. similar to the process outlined in industry standard TT05) that considers fatigue and cyclic aggressiveness, as applicable • Perform a "spike test" at the beginning of a pressure test to promote detection of flaws that would be near critical at the normal test pressure, thus minimizing the potential for these flaws to remain following the pressure test, and to minimize ductile flaw growth of subcritical flaws during long hold times at the normal hydrostatic test pressure. • Closely monitor the test for signs of yielding with a pressure-volume plot • Review and verify calibration certificates (e.g. to verify that calibration has been performed within 6 months) prior to using any measuring equipment for a pressure test • Utilize a documented procedure and/or diagrams for test recording instrumentation set up • Review pump specifications and pressure capabilities and compare with desired test pressure • Verify and document test equipment tolerances during the test via use of a certified dead weight tester or equivalent method • Utilize air compressors and drying pigs to minimize the amount of residual test water and/or consider the use of a corrosion inhibitor or biocide added to the test medium • Conduct caliper or geometry in-line inspection to detect pipe that has been overly expanded during pressure testing
<p>Training/Competency of Personnel Performing Activities</p>	<ul style="list-style-type: none"> • Operator qualification to conduct pressure testing • Knowledge of code requirements and regulations • Knowledge of real-time interpretation of test data and results (e.g. how to recognize potential leaks and potential yielding) • Knowledge of test equipment and pressure test set-up • Familiarity with test procedures and site-specific work plan

Table 8.8.3.19-1 Minimum Considerations for Development of Pre-Commissioning Pressure Testing Procedures and Quality Plan (continued)

<i>Inspection Requirements</i>	<ul style="list-style-type: none">• <i>Visual inspection of the pipe or the right-of-way to check for evidence of leaks during the pressure test</i>• <i>Leak detection may be aided by specific techniques including:</i><ul style="list-style-type: none">◦ <i>Dyes</i>◦ <i>Odorants or tracers</i>◦ <i>Acoustic monitoring equipment</i>• <i>Post-test deformation ILI, if applicable</i>
<i>Training/Competency of Inspection Personnel</i>	<ul style="list-style-type: none">• <i>Operator qualification to witness pressure testing</i>• <i>Knowledge of code requirements and regulations</i>• <i>Knowledge of real-time interpretation of test data and results (e.g. how to recognize potential leaks and potential yielding)</i>• <i>Knowledge of test equipment and pressure test set-up</i>• <i>Familiarity with test procedures and site-specific work plan</i>• <i>Knowledge of inspection equipment being used (e.g. Acoustic monitoring equipment)</i>

8.8.3.20 Pre-commissioning Inspections, Surveys, and Excavations

The requirement for pre-commissioning activities may be imposed in the regulation of certain projects. Alternatively, the company may choose to perform supplemental inspections, surveys, or exploratory excavations to verify the results of quality management activities or to generate baseline data for comparison with later integrity surveys. The operating risk level, project work scope, and cost versus benefit of having baseline data should be considered in the selection and application of specific survey methods. Pre-commissioning inspections or surveys may be performed before or after final tie-ins (golden welds), described in Section 8.8.3.21, below. Following these activities, excavations may be required to verify or remediate the findings. The inspections, surveys, and excavations should be conducted following OSHA and company applicable safety requirements. It should be noted that the inspections, surveys, and excavations may also be performed following commissioning of the pipeline. In this case, the qualification requirements for personnel as stated in 49 CFR 192, Subpart N and 49 CFR 195, Subpart G, Qualification of Pipeline Personnel are mandatory.

Pre-commissioning activities should include assembly, review, and acceptance for records to confirm they are 'traceable, verifiable, and complete' in the time lines required.

8.8.3.20.1 In-Line Inspection

In-line inspection (ILI) is performed to detect and remove flaws that can potentially affect the long-term integrity of the pipeline. These flaws can be manufacturing flaws that were not detected during testing and inspection by the manufacturer, or they can be new flaws that were generated during shipping, handling, fabrication, installation, or pressure testing of the pipe and pipeline components. By conducting pre-commissioning ILI, a baseline of the condition of the pipeline is created for comparison to future ILI results. This can assist in identifying changing conditions on the pipeline which could lead to degradation or failure versus those conditions which are considered stable. Another benefit to completing a pre-commissioning ILI is for timely identification of construction related practices which may potentially affect the short and/or long-term integrity of the pipeline

Pre-commissioning ILI is most commonly performed with water and a caliper or deformation inspection tool, which provides information on any anomalies which relate to geometry changes in the pipe wall. If an ILI tool with an inertial mapping unit is utilized, accurate mapping of the location of each weld and/or fitting can also be obtained. Additionally, wall loss anomalies such as corrosion or mill defects can be detected if the ILI tool has magnetic flux leakage (MFL) or ultrasonic wall thickness (UT) capabilities. Consideration should be given to which ILI technologies should be employed during the pre-commissioning inspection. Consideration should also be given to the sequence of ILI inspection relative to pressure testing. For example, ILI prior to pressure testing might identify construction related dents which may re-round during pressure testing. Conversely, ILI following pressure testing provides the benefit of identifying potential pipe yielding due to sub-standard materials.

Industry standards that are applicable to ILI include but are not limited to:

- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries;
- ASME B31.8, Gas Transmission and Distribution Piping Systems;
- API 1163, In-Line Inspection Systems Qualification Standard;
- NACE SP0102, In-Line Inspection of Pipelines; and
- ANSI/ASNT ILI-PQ, In-Line Inspection Personnel Qualification and Certification.

The potential quality concerns and options for quality control measures for ILI are contained in Table 8.8.3.20-1, below. Additionally, Table 8.8.3.20-1 shows the required training/competency of personnel performing ILI, as well as the inspection and records requirements.

Table 8.8.3.20-1 Minimum Considerations for Development of ILI Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none">• <i>Incorrect ILI tool deployed</i>• <i>ILI tool unable to traverse pipeline due to an impassible restriction</i>• <i>ILI tool unable to collect sufficient data</i>• <i>Degraded data (data quality issues)</i>• <i>Data collected is found to not accurately represent the condition of the pipeline</i>• <i>Mapping/Above ground marker systems do not function properly, leading to uncertainty in the location of anomalies</i>• <i>Speed of tool cannot be controlled</i>• <i>Inability to distinguish detrimental anomalies from non-detrimental anomalies</i>• <i>Insufficient sensitivity of ILI tool to potential anomalies of interest</i>• <i>ILI analysis errors</i>
QA/QC and Mitigation Options	<ul style="list-style-type: none">• <i>Selection of a high quality ILI service provider and tool</i>• <i>Compliance with API 1163</i>• <i>As-built documentation and other construction data provided to the ILI service provider prior to setup of tool</i>• <i>Performance of ILI tool and data quality checks (pre- and post-inspection)</i>• <i>Evaluation of tool to verify specifications are met</i>• <i>Generation of unity plots of excavation results, as applicable</i>• <i>Review ILI tabulation of piping components present including pipe diameter changes, wall thickness changes, and fittings</i>
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none">• <i>Training or OQ for pipeline company personnel and contract employees regarding launching, tracking, and trapping tools, as applicable</i>• <i>Training of inspection company personnel in analysis of ILI data</i>
Inspection Requirements	<ul style="list-style-type: none">• <i>Review that the performance of the tool was appropriate for the pre-commissioning ILI, including tool speed, amount of data captured, etc.</i>
Training/Competency of Inspection Personnel	<ul style="list-style-type: none">• <i>Training or OQ for ILI company personnel regarding the field operation and post run analysis of the ILI data</i>
Records Requirements	<ul style="list-style-type: none">• <i>Records of the setup of the ILI inspection tool and parameters</i>• <i>Checklists of tool operation (pre- and post-inspection)</i>• <i>Records of data recorded in run and analysis results</i>• <i>Operator qualification records, as applicable</i>• <i>Unity plots, as applicable</i>• <i>Data integration results</i>

8.8.3.20.2 Above-Ground Surveys

Above-ground surveys can be utilized to assess the condition of the coating and the external corrosion control system of buried pipelines. Examples of above-ground surveys include direct current voltage gradient (DCVG), alternating current voltage gradient (ACVG), and close interval surveys (CIS), also referred to as close interval potential surveys (CIPS).

DCVG and ACVG are utilized to evaluate the pipeline coating condition after the pipeline is backfilled; these surveys locate and classify coating anomalies. When the actual condition of the buried pipeline coating is significantly worse than the values used in the design of the CP, the system may not be able to provide effective protection against external corrosion.

CIS or CPIS is utilized to evaluate the quality of CP design and installation. Adequate CP of a buried or submerged pipeline can be achieved at various levels of cathodic polarization depending on the environment conditions. The CIS may be used to measure the level of polarization of the pipeline and also may be used to identify potential stray current interference not identified during the design phase.

Factors affecting the use or effectiveness of the inspection surveys include:

- The use of these inspections surveys may be precluded when the pipeline coating is susceptible to "electrical shielding."
- The pipe depth of cover may limit the sensitivity of detection. A deeper pipe depth of cover may lead to reduced sensitivity to detect coating anomalies and reduced ability of the surveys to accurately assess CP effectiveness.
- The presence of other metallic structures in close proximity the buried pipeline may impact the detection capabilities of the inspection surveys and the ability of the surveys to accurately assess CP effectiveness.
- The experience of the inspector also affects the quality of the survey.
- The inspection surveys use probes that require electrical continuity with the environment above the buried pipe. Asphalt cover and or concrete covers may limit the use of these surveys.
- The compaction and moisture content of the environment (backfill material) may impact the effectiveness of the inspection surveys.
- The presence of dynamic stray current may limit the use of these inspection surveys.

Industry standards that are applicable to above-ground surveys include, but are not limited to:

- NACE Standard TM0109-2009 Aboveground Survey Techniques for the Evaluation of Underground Pipeline Coating Condition.
- NACE SP0207-2007 Performing Close-Interval Potential Surveys and DC Surface Potential Gradient Surveys on Buried or Submerged Metallic Pipelines.

The potential quality concerns and options for quality control measures for above-ground surveys are contained in Table 8.8.3.20-2, below. Additionally, Table 8.8.3.20-2 shows the required training/competency of personnel performing pre-commissioning inspections, as well as the inspection and records requirements.

Table 8.8.3.20-2 Minimum Considerations for Development of Pre-Commissioning Inspection Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none"> • Incorrect locating of the pipeline • Inaccurate inspection equipment calibration or set-up • Improper calculation of the inspection signal at CP test stations • Improper reference of inspection data (anomaly location) to aboveground pipeline appurtenances or physical landmarks (e.g. road crossings, electrical transmission towers or poles, fences) • Not identifying locations with inadequate cathodic protection so that remediation can be applied
QA/QC and Mitigation Options	<ul style="list-style-type: none"> • Appropriate procedures for pipeline location • Documented equipment calibration • Appropriate procedures for equipment set-up and for performing the inspection surveys • Documentation of the inspection equipment operating conditions (inspection signal magnitude) • Redundant tools to document the location(s) of inspection data (GPS, measuring wheel, laser range finders) and anomalies • Resurvey of selected locations to confirm repeatability • Survey spot-checks with alternate personnel to confirm repeatability • Proper data alignment procedures between inspection results and pipeline as-built drawings • Resurvey of areas after remediation of cathodic protection has been completed
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none"> • Minimum experience required to understand the limitations of the inspection surveys, as defined by the company • Operator qualified to perform the inspections surveys, as applicable • Minimum company-required certification, such as NACE Certified Cathodic Protection Technician (CP Level 2)
Inspection Requirements	<ul style="list-style-type: none"> • Regular inspection of collected data for consistency and accuracy (daily if practicable) • Review of inspection equipment setup parameters
Training/Competency of Inspection Personnel	<ul style="list-style-type: none"> • Minimum experience required to understand the limitations of the inspection surveys, as defined by the company • Minimum company-required certification to inspect survey data and surveys performed by other staff
Records Requirements	<ul style="list-style-type: none"> • Inspection records maintained for the life of the pipeline • OQ records, as applicable

8.8.3.20.3 Excavations

Excavations, often referred to as "digs" are the act of uncovering a buried pipeline to perform an examination. Excavations may be required to verify or remediate the findings from ILI or above-ground surveys. When pre-commissioning inspections and/or surveys identify anomalies on the pipeline under

construction, excavations are used to expose the anomaly to determine the direct cause and remediate or repair the affected area.

It is important to have a feature locating protocol or procedure in place to facilitate accurate location of the anomalies identified by inspection. The accuracy of the ILI and above-ground survey data may impact the amount of pipe that will need to be excavated to expose the anomaly or anomalies. Because there is an inherent risk of damaging the pipe or the coating during the excavation process, the amount of pipe excavated should be minimized provided sufficient pipe is exposed to meet the objectives of the excavation.

Field activities related to locating anomalies, excavation, and repairs should be conducted following applicable OSHA and company safety requirements.

The locating protocol should include more than one aboveground reference point to be used to mark the location on the anomaly. When discrepancies between the inspection data and field measurement are found, they should be resolved before the excavations commence. The source of the discrepancy and how it was resolved should be documented.

The pipeline excavation protocol should include, at a minimum, the following:

- Location of reference points;
- Minimum length of pipe to be exposed;
- Type of coating repair material to use and or pipe repair when required (e.g. steel sleeve, cut-out);
- Type of inspections to be conducted (e.g. visual inspection, UT wall thickness measurements, coating dry film thickness, coating adhesion, pipe-to-soil potential measurement);
- Guidelines to minimize damage of the pipe (including the coating) during the excavation and backfilling activities; and
- Coating and pipe repair procedures.

Refer to Section 8.8.3.10, above, for information on coating holiday inspection (jeeping) and coating repairs. Additionally, refer to Section 8.8.3.16, above, for information on backfilling the pipe following the completion of excavation and repair activities.

The most likely direct cause(s) of an anomaly should be identified when the pipe is exposed. A trained and qualified examiner should be present during the excavation process to increase the probability of identifying anomalies that may be generated during the excavation process.

The potential quality concerns and options for quality control measures for excavations are contained in Table 8.8.3.20-3 below. Additionally, Table 8.8.3.20-3 shows the required training/competency of personnel performing pre-commissioning inspections, as well as the inspection and records requirements.

Table 8.8.3.20-3 Minimum Considerations for Development of Excavation Procedures and Quality Plan

<p>Potential Quality Concerns</p>	<ul style="list-style-type: none"> • <i>Excavating in the wrong location (inadequate anomaly locating protocol) - anomaly not found or an extended length of pipe exposed to locate anomaly</i> • <i>Inadequate pipe excavation procedure - damage to the pipe and or coating during excavation</i> • <i>Inaccurate ILI anomaly identification or location - anomaly not found during excavation</i> • <i>Inadequate above-ground survey location - anomaly not found during excavation</i> • <i>Data gathered in excavations is not accurate or complete, or relies excessively on subjective judgment</i> • <i>Anomaly reported by ILI or above-ground surveys incorrectly matched to field observations - e.g., anomalies that may have been generated during the excavation may be considered as the anomalies reported by the ILI or the above-ground surveys</i> • <i>Incorrect, inappropriate, or inaccurate flaw assessment procedures leading to unconservative conclusions regarding the effect of the flaw on pipeline integrity</i> • <i>Inadequate repair procedures - anomalies not properly repaired</i> • <i>Inadequate excavation contractor - pipe or coating damage</i> • <i>Inadequate coating and backfill procedures</i>
<p>QA/QC and Mitigation Options</p>	<ul style="list-style-type: none"> • <i>Appropriate, documented procedures for the excavation activities, including:</i> <ul style="list-style-type: none"> ◦ <i>Anomaly location procedure</i> ◦ <i>Pipeline excavation procedure</i> ◦ <i>Exposed pipe inspection procedure</i> ◦ <i>Anomaly characterization procedure</i> ◦ <i>Pipe anomaly assessment procedure</i> ◦ <i>Pipe anomaly repair procedure</i> ◦ <i>Pipe coating repair procedure (see Section 8.8.3.10, above)</i> ◦ <i>Backfill procedure (see Section 8.8.3.16, above)</i> • <i>Trained or qualified personnel</i>
<p>Training/Competency of Personnel Performing Activities</p>	<ul style="list-style-type: none"> • <i>Minimum training/experience requirements for personnel performing the following activities should be defined by the company:</i> <ul style="list-style-type: none"> ◦ <i>Pipe examination/NDT</i> ◦ <i>Excavation</i> ◦ <i>Flaw assessment</i> ◦ <i>Pipe repair</i> ◦ <i>Coating repair (see Section 8.8.3.10, above)</i> ◦ <i>Backfill (see Section 8.8.3.16, above)</i> ◦ <i>OQ requirements, as applicable, for activities performed after commissioning</i>

Table 8.8.3.20-3 Minimum Considerations for Development of Excavation Procedures and Quality Plan (continued)

<i>Inspection Requirements</i>	<ul style="list-style-type: none"> • <i>Regular inspection of collected data for consistency and accuracy (daily if practicable)</i> • <i>Review of excavation inspection data, ILI inspection and above-ground survey data for consistency and accuracy</i> <ul style="list-style-type: none"> • <i>Regular inspection of pipe or coating repair activities for consistency and accuracy (daily if practicable)</i>
<i>Training/Competency of Inspection Personnel</i>	<ul style="list-style-type: none"> • <i>Training and experience for In the ditch testing personnel should be defined by the company as applicable</i> • <i>Minimum training and experience required to review and validate data collected at the excavations should be defined by the company</i> • <i>Minimum training and experience required to review and validate coating or pipe repairs should be defined by the company.</i>
<i>Records Requirements</i>	<ul style="list-style-type: none"> • <i>Excavation inspection reports, including all applicable location data</i> • <i>Pipe inspection reports, including disposition of inspected anomalies</i> • <i>Repair reports, as applicable</i> • <i>Operator qualification records, as applicable, if activities are performed following commissioning</i>

8.8.3.21 Final Tie-In Welds

Final tie-in welds, sometimes referred to as "golden welds," are welds made between two hydrostatically tested sections of piping. These welds are not pressure-tested and are often made under more adverse condition (i.e. higher stress). Therefore, the quality of the completed weld is more critical than for welds that are hydrostatically tested. The information contained in Sections 8.8.3.7.1, Welding, 8.8.3.8, Non-Destructive Testing (NDT) of Welds, and 8.8.3.17, Tie-Ins, is applicable to final tie-ins, with the addition of concerns listed in this section. If additional piping is used at final tie-in location, the piping should be previously pressure tested to meet the regulatory requirements before installation into the piping segment ("pretested pipe").

CFR regulations require the number of untested welds to be minimized.

Industry standards that are applicable to final tie-ins include, but are not limited to:

- *API 1104, Welding of Pipelines and Related Facilities;*
- *ASME Boiler and Pressure Vessel Code (BPVC), Section IX, Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators;*
- *ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries; and*
- *ASME B31.8, Gas Transmission and Distribution Piping Systems.*

The potential quality concerns, options for quality control measures, required training/competency of personnel performing final tie-ins, and the inspection and records requirements for final tie-ins are contained in Tables 8.8.3.7-1, 8.8.3.8-1, and 8.8.3.17-1, above. Additionally, the pressure test of any "pretested pipe" used at a final tie-in location should be documented, reviewed for suitability, and retained.

8.8.3.22 As-Built Documentation

The completed as-built documentation package is compiled from the as-built survey and/or pipe data log, as well as the pre-commissioning hydrostatic test records, pipe and component MTRs, etc. In this step, all the data for the pipeline is brought together; MTRs, inspection reports, and component documents are tied to the associated installation locations along the pipeline. While the completed as-built document may not contain all information about a segment of pipe, it should reference the location or document that contains the information of interest. In addition, the as-built documentation should be 'traceable, verifiable, and complete.'

The potential quality concerns and options for quality control measures for as-built documentation activities are contained in Table 8.8.3.22-1, below. Additionally, Table 8.8.3.22-1 shows the required training/competency of personnel performing as-built documentation activities, as well as the inspection and records requirements.

Table 8.8.3.22-1 Minimum Considerations for Development of As-Built Documentation Procedures and Quality Plan

Potential Quality Concerns	<ul style="list-style-type: none">• Missing/inaccurate as-built survey information• Missing/inaccurate pipe and component documentation• Missing/inaccurate hydrostatic test information
QA/QC and Mitigation Options	<ul style="list-style-type: none">• Appropriate as-built documentation requirements and procedures in place and known to relevant personnel• Established QA/QC procedures for collected data and data integration• A single point of responsibility assigned for as-built documentation
Training/Competency of Personnel Performing Activities	<ul style="list-style-type: none">• Understanding of company as-built documentation requirements and procedures• Familiarity with project details, locations, and materials being used
Inspection Requirements	<ul style="list-style-type: none">• Regular QA/QC of collected data for consistency and accuracy• Verification of documentation and records
Training/Competency of Inspection Personnel	<ul style="list-style-type: none">• Understanding of company as-built documentation requirements and procedures• Familiarity with project details, locations, and materials being used
Records Requirements	<ul style="list-style-type: none">• All records should be maintained for the life of the pipeline• Redundant copies of the as-built survey should be maintained

9.0 CONTINUAL IMPROVEMENT

9.1 General

Organizations shall plan, manage and take appropriate measures to enable the continual improvement of the QMS as well as associated procedures and processes. Both the effectiveness of the QMS and its continued relevance to the organization's corporate goals and objectives shall be evaluated through this process. Improvements may take the form of changes to the overall policy, the corporate objectives for quality, as well as the individual elements of the QMS and their associated processes and procedures.

Guidance

The continual improvement process is an integral part of QMS, and should include management's commitment to monitor and evaluate performance measures.

The continual improvement process should follow the Plan-Do-Check-Act (PDCA) model. Figure 9.1-1 illustrates the elements of a continual improvement process using the PDCA model³. This continuous process of identifying and analyzing the QMS (Plan), developing ways to address issues (Do), measuring the effectiveness of actions (Check), and implementing solutions (Act) should be utilized to verify the QMS remains relevant to the business, is achieving its goal of promoting quality, and is being improved and enhanced as needed.

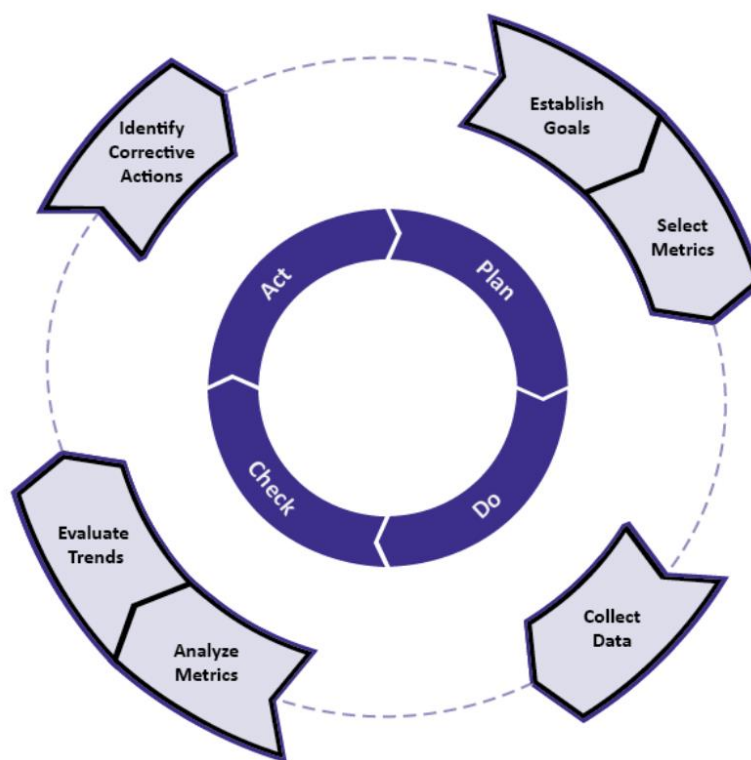


Figure 9.1-1. Elements of a Continual Improvement Process using Plan-Do-Check-Act

PHMSA describes the PDCA process for continual improvement, in the document titled "Guidance for Strengthening Pipeline Safety Through Rigorous Program Evaluation and Meaningful Metrics", in the following way:

³ From PHMSA's "Guidance for Strengthening Pipeline Safety Through Rigorous Program Evaluation and Meaningful Metrics," dated July 10, 2014

"Specifically, program evaluation should be the fundamental process of an operator's efforts to facilitate continuous improvement

- PLAN: establish the objectives and processes necessary to deliver results in accordance with the organization's policies and the expected output (goals). By establishing output expectations, the completeness and accuracy of the process is also a part of the targeted improvement.*
- DO: implement and execute the processes and collect information and data for analysis as part of the "CHECK" and "ACT" steps.*
- CHECK: analyze the information and data against policies, objectives and requirements; report the results to determine if objectives and expected results are being achieved; look for trends and deviations in implementation from the goals of the plan; and analyze the differences to determine their root causes and what corrective actions may be implemented to improve the process or the results.*
- ACT: identify and implement the corrective actions where significant differences between actual and planned results have been identified. These corrective actions may apply to the completeness and accuracy of the procedures and process as part of the targeted improvement."*

The most effective way to continuously improve the QMS is to use a combination of both formal and informal processes to systematically review the existing QMS. This information can then be used to measure performance against the requirements of the management system.

The following types of processes and activities will have an impact on the ability to continually improve the QMS:

- 1. Management Review and QMS Audits;*
- 2. Control of Nonconformance;*
- 3. Learning from Events;*
- 4. Management of Change (MOC); and*
- 5. Monitoring and Measurement.*

9.2 Management Review and QMS Audits

The effectiveness of the QMS shall be continually reviewed and improved through systematic management reviews and *audits* of the QMS. The processes to be used for each of these activities shall be documented as part of the QMS, along with requirements for re-assessment intervals. The outputs of management reviews and QMS audits shall include documented approval by company management.

9.2.1 Management Review

Management Reviews shall be undertaken as set out in Section 6.1.5 of this document and should be carried out in a way that will verify the following:

1. The Quality Policy still reflects the organization's position on maintaining quality during the design and construction phases;
2. The Quality Objectives continue to support the overall corporate objectives;
3. The QMS reflects current regulatory requirements and recognized and generally accepted good industry practices;
4. Management supports the QMS;
5. Management reviews are conducted at a defined frequency, and actions are undertaken to address findings;
6. Data are analyzed in a way that will identify trends and facilitate an appropriate response to quality issues;
7. Previous QMS audit action items have been closed or are in the process of being addressed;
8. The organization is in conformance with the QMS;

9. The effectiveness of the QMS is being evaluated;
10. Management Review minutes are circulated to appropriate personnel; and
11. The MOC process is used to facilitate the appropriate management of changes to the QMS.

9.2.2 QMS Audit

An audit process shall be in place to verify that the organization is evaluating the performance of the QMS. For each QMS audit, a written plan or document may include the scope of the audit, people or positions to be interviewed, checklists or listing of documents to be reviewed, and other relevant information that will enable the auditor/audit team and audit organizer to have a common understanding of the audit's purpose. This information may be stated in a "terms of reference" (TOR) document, proposal, audit protocol, or similar and should be fit for purpose, as determined by the scope and scale of the audit.

Guidance

Careful consideration should be given to the type of audit conducted and the intended outputs of each audit. Audits of the QMS can be conducted by an internal audit function (such as a self-assessment or corporate audit) or by a third party auditor or consultant. Because of the reliance on contractors and suppliers during construction and installation of pipelines, additional audits may be necessary to determine if suppliers and contractors are meeting the organization's QMS requirements.

The QMS can also be evaluated in its entirety or by element; however, during each audit cycle, the QMS audits shall determine, at a minimum, if the following are occurring:

1. The Quality Policy is understood throughout the organization;
2. Staff understand their role in achieving the Quality Objectives;
3. The written QMS is comprehensive and relevant to the organization's business and assets;
4. The requirements of the QMS are being met as intended;
5. Quality audits are conducted on a regular basis, and actions are undertaken to address findings;
6. Preventive actions are taken to minimize the likelihood of foreseeable quality issues;
7. Corrective actions are taken to minimize the likelihood of a similar quality issue being repeated;
8. Quality issues are being addressed in a timely manner;
9. Lessons learned and quality concerns are circulated to appropriate personnel;
10. Appropriate training is being done to enable conformance to the QMS; and
11. The MOC process is used to facilitate appropriate management of changes to the QMS.

9.2.3 Review and Audit Reports

The QMS shall require findings or results of audits and management reviews to be reported in an appropriate form and communicated to appropriate personnel. Requirements for document control and retention time are addressed in Section 5.3, above.

9.3 Addressing Findings and Recommended Actions

Documented procedures or processes shall be established and maintained as part of the QMS to address nonconformances in an appropriate manner. Organizations shall verify these procedures or processes address the following:

1. Identifying and investigating nonconformances;
2. Determining causes of nonconformances;
3. Determining which type(s) of action(s) shall be implemented – corrective or preventive;
4. Preventing recurrence of nonconformances;
5. Documenting preventive and corrective actions to be taken;
6. Implementing actions;
7. Promoting appropriate communication; and
8. Reviewing the effectiveness of actions following implementation.

Both corrective and preventive actions may be used, as appropriate.

Guidance

Corrective actions should be taken to address findings such as those resulting from incident investigations, audits and management review activities. Preventive actions should be taken in response to proactive activities, such as risk assessments and near misses. Both corrective and preventive actions may take the form of, for example, revisions to procedures, development of new procedures, additional oversight, etc., all of which should be implemented as appropriate following the MOC requirements.

9.4 Learning from Events

Learning from events is critical to the continual improvement of the QMS. Formal, consistent, standard processes, such as incident investigations, shall be used to verify that a continuous improvement loop is in place to learn from events. In addition to formal processes, informal opportunities, such as employee concerns and impromptu feedback, should be utilized in an appropriate manner to improve the QMS.

Guidance

The ultimate goal of learning from events should be to identify necessary improvements to the QMS and associated processes and procedures. Examples of documents or activities that may be impacted include:

- *The written QMS document(s);*
- *Procedures for procurement and evaluation of contractors;*
- *Materials specifications and requirements;*
- *Fabrication and factory acceptance testing;*
- *Contractor qualifications, competence, and oversight;*
- *Contractor procedures for construction, installation, testing, and inspection;*
- *Company procedures for construction, installation, testing, and inspection;*
- *Inspection and preventive maintenance schedules;*
- *Operating philosophy and operating procedures; and*
- *Spare parts requirements.*

In all cases, when changes are made to the QMS, those changes shall be managed in accordance with the MOC requirements.

9.4.1 Reactive Learnings

The QMS shall include a process for evaluating incidents and events related to quality in a manner that will promote determination of the root cause of the event, incorporation of the findings into the QMS, and communication of important information to employees to maximize the likelihood that quality issues are not repeated.

If the root cause of a failure of a pipeline in operation is determined to be related to a construction quality issue, actions shall be taken to determine if a similar situation could occur given the existing QMS and its associated processes and procedures. Efforts shall be taken to improve the QMS, as well as related procedures and processes.

Guidance

Reactive activities, such as incident investigations, utilize information from the past to make improvements to the QMS. These activities are undertaken to prevent similar events in the future.

Three types of quality-related incidents should be evaluated for impact on the QMS:

1. *Poor quality construction practices that are identified during construction activities (such as improper backfilling noted by the inspector);*
2. *Poor quality construction, such as substandard welds, inferior material, etc., that is not identified*

until after construction has been completed (but is, for example, identified during hydrostatic testing.); and

3. Incidents that occur on in-service pipelines, which are determined to be caused by quality issues during the pipeline's construction and/or installation.

Reactive learnings can also be captured from nonconformance reports (NCRs) during construction, quality reports, environmental reporting, and other similar processes that highlight quality problems as contributing causes to such events.

9.4.2 Proactive Learnings

Proactive activities, such as near miss investigations, utilize information to predict possible quality problems and correct them in a proactive manner. Proactive activities can be utilized to identify potential quality concerns before an event occurs.

Guidance

The following activities provide opportunities to learn in a proactive manner:

1. Near miss evaluations, e.g., discovery of poor quality material prior to beginning construction, discovery of inappropriate weld procedure prior to start of work;
2. Incorporation of learnings from reports and investigations from industry incidents;
3. Manufacturer reports;
4. Hazard identification studies; and
5. Risk assessment.

9.4.3 Informal Opportunities for Learning

Informal activities should also be considered as a means for capturing improvements to the QMS. Such activities may include, but are not limited to:

- Employee and contractor concerns and suggestions;
- Experiences with disgruntled personnel, personnel with ineffective training, or intentional negligence;
- On-the-job observations, e.g., inaccurate procedures;
- QA/QC observations; and
- Potential improvements identified by employees or contractors through the regular use of the QMS and related procedures or documents.

Guidance

Once informal opportunities for learning are presented, the company may choose to perform an analysis to determine the root cause of the identified issue, as described in Section 9.4.1, above. It is important to note that the root cause analysis should not be used to blame individuals, but to identify improvement opportunities for the QMS and associated processes and procedures, especially in the case of disgruntled employees.

9.5 Management of Change

The MOC process shall be utilized when making changes to the QMS as a result of any continual improvement or other activity. Changes shall be communicated appropriately to personnel who could potentially be affected by the change, and any necessary training shall be conducted.

See Section 5.4 above for details regarding the requirements for MOC.

9.6 Monitoring and Measurement

Appropriate performance metrics shall be in place to provide information that will help the organization improve the QMS and communicate pertinent information. A combination of leading and lagging metrics should be considered in an effort to provide the most effective improvement.

Guidance

Lagging metrics are derived from events that have occurred in the past, such as quality-related incidents, nonconformances, citations, etc. Leading indicators are those which look forward and indicate potential problems that could occur if corrective action is not taken.

Metrics should allow the organization to determine the following, at a minimum:

- 1. Are appropriate controls in place to manage quality issues and risks associated with construction and installation?*
- 2. How well is the organization conforming to the QMS requirements?*
- 3. Are procedures that affect quality being followed as intended?*
- 4. Is training being carried out in an appropriate manner and at appropriate intervals? and*
- 5. Are action items from management reviews and audits being addressed, tracked, and closed as required by the QMS?*

Operating companies should define performance metrics to effectively monitor and measure the QMS. Additionally, the basis of the metrics should be documented. Types of metrics that should be considered include:

- QMS implementation metrics, which may be used to identify potential organizational or systemic issues (including failures to follow procedures) that may contribute to a reduction in pipeline construction quality.*
- Project- or activity-specific metrics, which may be defined due to unique construction characteristics, such as unique environments/encroachments through which the pipeline will pass, or to examine the performance of specific types of construction activities, such as those identified in Section 8.8, above.*
- Program effectiveness metrics, which may include metrics from periodic self-assessments, internal and/or external audits, management reviews, or other self-critical evaluations that assess program effectiveness.*

Interaction among metrics should also be evaluated. Organizations should make efforts to understand changes in the reported metrics in addition to recording and reporting them. For example, if the number of deficient welds is reduced over a period of two years, what influenced the change? Was there an increase in oversight on jobsites? Has the organization taken more of an active role in reviewing contractor welding procedures?

In addition to defining performance metrics, the operating company should develop and document plans or procedures for collecting, processing, and validating the metrics, which include:

- Organizational responsibility for collection of metric data;*
- Required qualifications of personnel gathering and processing the metric data;*
- Acceptable data sources;*
- Timing limits for the collection and processing of metric data;*
- Review and validation process for the collected and processed data to identify potential errors, and uncertainties; and*
- Required formats/systems for raw metric data retention, retrieval, and analysis, as well findings from the metrics.*



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